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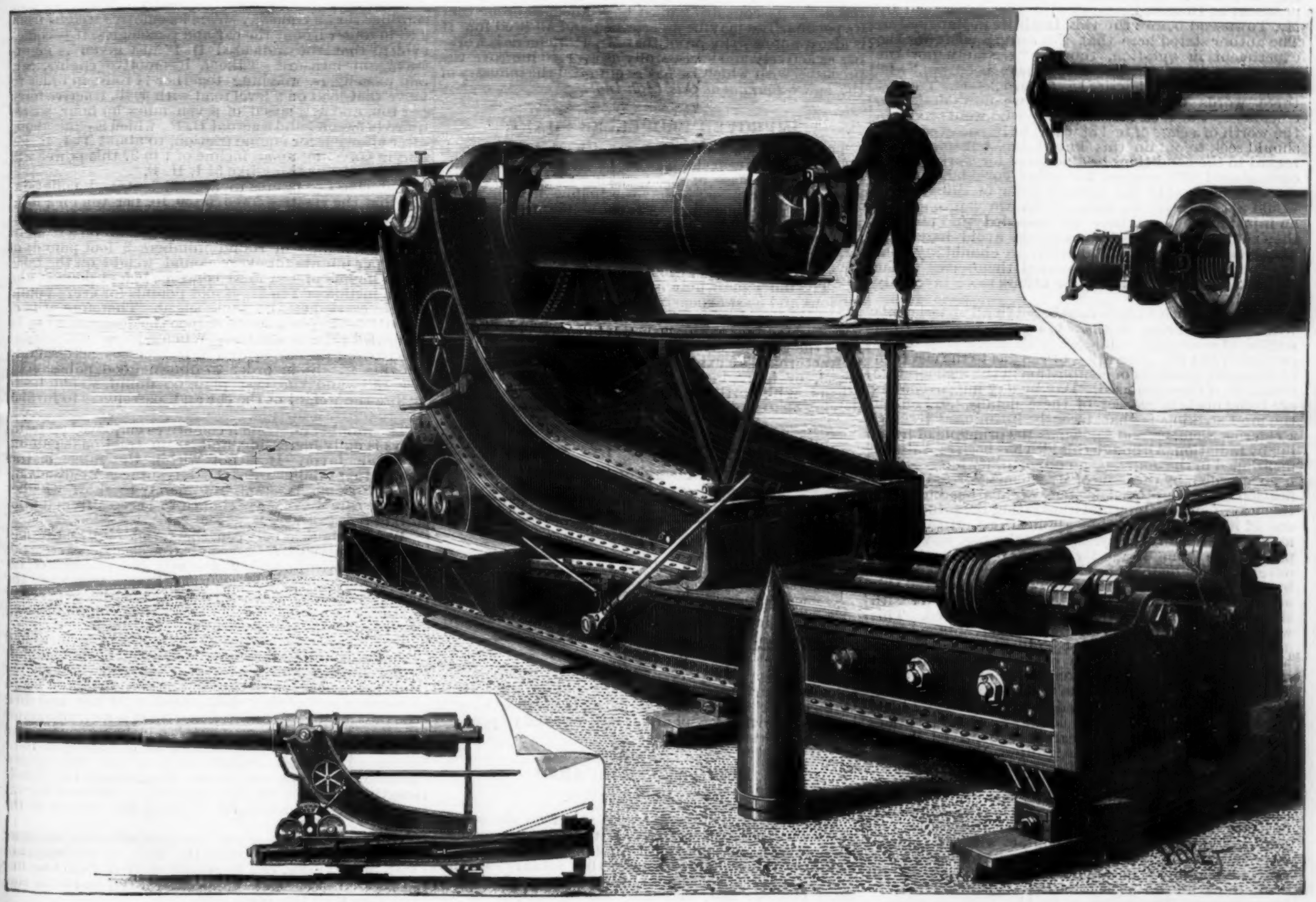
THE THIRTEEN INCH DE BANGE GUNS.

CONSIDERABLE progress has lately been made in the manufacture of heavy guns. Less than thirty years ago the most powerful piece of our artillery could throw a 25 lb. ball only a little more than a mile; whereas with Colonel De Bange's new gun a projectile weighing about 1,000 lb. can be thrown a distance of 11 miles. This gun forms one of the most important exhibits at the Antwerp Exposition.

The principal improvements in arms have been made since 1870, and much of this progress is due to private enterprise. Colonel De Bange's new piece of artillery is made of steel, and is of 13 in. caliber; it weighs 37½ tons, and is 37 feet long; its exterior diameter is 3 ft. 3 in. at the breech and 1 ft. 8 in. at the muzzle. The weight of the charge of powder is about 360 lb., and of in use in our artillery. Notwithstanding their size, the parts can be manipulated, by hand, by two men without the aid of intermediate gearing or machines.

The gun rests on a carriage of steel plate, the cheeks of which are considerably curved. The carriage is supported by a heavy metal chassis, on which it slides in the recoil and when being returned to position for firing. To diminish the recoil, the carriage is provided with a hydraulic brake, which consists of movable cylinders, which slide on pistons fixed on the chassis, and safety valves are provided. A spring chain limits the movements of the carriage when being placed in position, as well as in the recoil. The pivot of the chassis being at the center of gravity of the entire apparatus, rollers can be dispensed with, and are replaced by simple runners or shoes resting on a circular track. By means of a little hand windlass the chassis can be



THE FRENCH DE BANGE GUN—13 INCHES CALIBER; LENGTH, 37 FEET; RANGE, 11 MILES; PROJECTILE, 1,200 POUNDS; CHARGE, 360 POUNDS.

the projectile 1,200 lb. This great gun has never been tried, but the inventor asserts that with a maximum charge he can obtain an initial velocity of 2,132 feet and a range of eleven miles; and, as cannon are now made with such exactness and accuracy that there is, usually, very little difference between the actual and the calculated velocity, the claims of the inventor will probably be verified.

In 1882 Colonel De Bange began to work on his 13 in. gun, and he took out patents as the director of the Cail Works. The construction of the gun was undertaken by this establishment in conjunction with the Societe des Forges de la Marine, at St. Chamond, and Messrs. Marrel Bros., of Rive de Gier. The tube and the hoops or rings, as well as the chassis, were made in Paris, at the Cail Works, and nearly a year was required for the completion of these parts. The interior diameter of the steel tube was at first only 11·8 in., but was increased to 13 in. by boring with an ingenious apparatus invented by Colonel De Bange. The tube was re-enforced throughout its entire length by a series of strong steel rings welded on. These rings were turned in a biconical shape, which form was also given to the exterior surface of the tube, so as to render all the parts solid and firm. This arrangement prevents the broken part, in the case of a rupture, from being thrown backward. The gun is afterward rifled. The breech presents no important novelty; the fermature consists of a screw with interrupted threads, with the De Bange gas check turned on its point, and wedges placed at the back enable it to support the carriage and gun during the recoil.

For taking high aim, the gun is provided in the under part, below the trunnions, with a toothed rack, which is acted upon by cog wheels, operated by means of a crank on each side of the carriage. The platform upon which the operators stand is about 7 ft. 6 in. from the ground. To lift the charge to the opening in the breech, a little hand crane is used, which consists of an elbow lever, from one end of which the guide for the projectiles is suspended, and on the other end is a toothed sector, which is turned by means of a lever.

The two projectiles exhibited at Antwerp are solid, and are made of forged steel; one weighs 900 lb. and the other 1,200 lb., the latter being nearly four feet high.

This new gun seems to combine all the advantages of safety, lightness, and economy, and while it is much lighter and less expensive than the famous 100 ton cannon of neighboring powers, it has greater range and penetration.—*L'Illustration.*

DR. LENNOX BROWNE of Chicago holds that the use of stimulants and tobacco is detrimental to the singing voice, and he has secured the written opinions of nearly four hundred singers, nearly all of whom state that the less the vocalist has to do with alcohol the better. The singers include no Germans or Italians.

MR. F. SIEMENS' IMPROVED BOILER FURNACE.

THE general problem of adapting gaseous fuel to steam raising and other industrial purposes is divisible under many heads. It is to this that must be ascribed the occasional failures and general difficulties experienced by beginners in the art of gas firing; for it almost deserves to be classed as such. There is no "royal road" to success in the application of gaseous fuel. The theoretical principles of its production and combustion may be thoroughly appreciated by an engineer who will yet meet with repeated disappointments when he comes to put his ideas into practice. This does not imply that the theory is useless—far otherwise. Unless the theory of combustion, as the phenomenon attending the rapid oxidation of solid and gaseous carbonaceous matters, is fairly mastered, any attempts to manipulate the process must be like groping in the dark. What it does mean is that while the theory is simple, and the same expression of it applies to all possible practical developments, these latter are so various, and their efficacy depends upon so many influences scarcely to be foreseen, that the most accomplished student of theoretical principles is liable to be nearly as much puzzled in action by unexpected failures as would be one who never works otherwise than by guessing at the truth. When the question is asked, whether gas can be profitably substituted for solid fuel for any given purpose, there is ample warrant, drawn from experience in other departments, for an affirmative reply. When the work of adaptation comes to be undertaken, however, it almost invariably happens that some difficulties are discovered which apparently did not exist in connection with other applications of the same class of fuel. The reliance of the designer upon his theory is consequently shaken, and his resources in practical expedients are severely strained before he can secure the expected result. When the designer does not possess the inborn gift of overcoming practical difficulties, all his learning will not help him to grasp that success which appears to be so provokingly near, and is yet so far beyond his reach. This is the real reason for the occasional failures in the use of gaseous fuel which are sometimes spoken of in meetings of professional men. Now and

then an engineer who occupies a prominent position delivers himself oracularly of a condemnation of gaseous firing for some special purpose. He probably considers himself superior to the suspicion of ignorance of his subject, and is, indeed, generally able to give a clear expression of the principles involved. His dispositions appear to be sufficiently complete; and, therefore, when the result does not answer his expectations, he naturally considers himself entitled to speak in disparagement of the system. This method of trying a novel process is not uncommon; but it is very misleading to the experimentalist and to all who follow his lead. When there is a question of the adaptability of a new principle, the fact of its having succeeded in some hands is worth more than any amount of condemnation from a host of eminent authorities with whom it may have failed.

One of the essentials of success in the application of gaseous firing appears to be an absence of preconceived ideas as to how it ought to be used. There is for all designers a danger lest they should be led to decide beforehand, consciously or unconsciously, that the result they desire must be obtained in such a way, or not at all. It requires an open mind, of a rare degree of teachability, to throw over all previously received notions of how a thing is to be done, and to alter or modify one's designs freely in order to deal with unexpected and sometimes mysterious influences. Too frequently the contrary plan of action is preferred. The first-conceived design is, perhaps unconsciously, adopted as a type; and the designer wearies himself in trying to make it fit the novel conditions which meet him as his experience widens. Sometimes he succeeds, wholly or in part, but more frequently he retires disgusted from the struggle. An example which looks very much as though its conception might have been in this spirit may be found in the instance of the steam-raising experiment at Bradford, narrated in the paper read by Mr. Townsend before the Gas Institute in Manchester. The author stated here that the arrangement for the experiment in question, though "certainly not the best way in which the gas could have been applied," was "an arrangement desired *by the promoters*." The last three words convey the point we now desire to elucidate. The idea that anybody who wants to learn the worth of a class of fuel of which he has no experience should seek to obtain this knowledge, not solely with regard to the conditions best adapted for working, but encumbered with respect for other considerations, is simply a reversal of the natural order of things. We would not willingly do these unknown "promoters" an injustice; and so it may be conceded that perhaps they could not, in the circumstances, avoid handicapping gaseous fuel. If so, however, we should say that they ought not to have committed themselves to the experiment, but have left it for others more favorably situated.

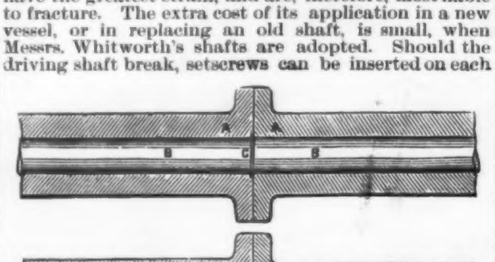
The great truth to be remembered in all experiments with gaseous firing is that failure is possible from neglect of essentials connected with every step of the process—from the generation of the gas to the last turn of the spent products of combustion in the regenerative channels, if these are used. Day by day improvements are being made in respect of these details, and one of the most striking is that recently introduced by Mr. Frederick Siemens, and known as the principle of heating by radiation. Although this idea has been repeatedly mentioned in the *Journal*, an opportunity has recently been afforded, by the issue of Mr. Siemens' patent specification for his improved system of heating boilers in this way, for describing and illustrating the principle in one of its most remarkable applications. Hitherto, it may be safely said, the question of the best way to dispose of the flame of gas for heating furnaces, etc., has never been studied. It has been considered sufficient to bring the gas into the furnace, of whatever kind this might be, and to let it burn in as close contact with the surfaces to be heated as could be procured. This was, indeed, regarded as the special advantage of the gas-flame—the article could be plunged into it, as in the blowpipe jet. The idea of utilizing the radiant heat of a gas-flame was seldom attempted. Carbonic oxide and hydrogen gas, from the ordinary type of producer charged with non-bituminous fuel, possesses little radiant power; and common coal gas, which possesses a good deal, was generally carefully deprived thereof by mixing air with it before ignition. To all this the system of Mr. Siemens is a direct reversal. He makes gas combustion chambers large where they were formerly small; and declares that a gas-flame should never, in any circumstances, touch the surfaces it is intended to heat. After the flame is completed, the products of combustion may be placed in contact with the surfaces to be heated; but not before. The reasoning for this course is simple: The combination of combustible and comburant known as combustion depends upon the temperature. The hotter it is, the more complete is the operation. Excessive cold absolutely stops the operation, as is proved by the extinction of flame by putting a screen of wire gauze in its way. Between the action of the wire gauze and that of any foreign body in contact with a live flame there is a relation of degree. No matter how hot the foreign body may be, it is of necessity much colder than the flame; and, therefore, by so much as it draws heat from the latter it depreciates the completeness of its combustion. Hence the plea advanced by Mr. Siemens for the protection of flame from contact with anything until the process of combustion is finished. Keeping this reasoning (the force of which is obvious) well in mind, it will be seen that to place flame in absolute contact with such a comparatively cold body as the shell of a steam-boiler is nearly as destructive to cumbustion as would be the interposition of a piece of wire gauze. To overcome the difficulty, Mr. Siemens adopts the device illustrated in the accompanying engraving. The gas comes from the producer by the channel, A, which may be closed by the valve, B. Upon issuing from this channel into the combustion chamber, C, it meets air coming from the channel, D, which air may be heated by passing underneath the bottom flue of the boiler in a special channel, O. Ignition is first started at E, and thereafter proceeds in the chamber, C, the throat of which, F, leading into the boiler-flue, is smaller than the latter. This last is an important point, as it insures that the flame does not touch the boiler to begin with. The flame then burns through the length of the boiler-flue, and is prevented from touching the iron by the thimbles, rings, or arches as at K, L, M, which serve to keep it in the middle of the flue. Finally, the outlet passage, G, is also smaller than the flue. The products of combustion pass under the bottom of the boiler, in the usual way, by the flue, H; and, as there is every reason for making them pass as closely as possible in contact with the shell, there are baffles, P, which deflect them accordingly. The baffles, N, are intended for the better heating of the air in its passage through the channel, O. The whole system is thus clearly defined, and its efficiency in insuring perfect combustion of the smokiest gas-flame may be easily demonstrated by a small experiment. Two or three lengths of mica Argand chimneys, placed end to end, and connected at one end with an aspirating-pipe, will represent a boiler-flue, and allow the course of the flame to be seen. Two or three disks of thin brass, with a hole in the middle, placed at intervals in the mica flue, will represent the rings or arches in the boiler-flue. If then a smoky (not atmospheric) gas-flame, such as may be

obtained from the end of a pipe ⅛ or ¼ inch in diameter, is introduced into the open end of the mica flue, it will burn completely in the middle without touching it, and not a particle of soot will deposit on the tube or disks. Of course, if these are removed or improperly placed, the model will be thickly coated inside with soot.

This is a remarkable example of the way in which the use of gaseous firing must be studied, in order that its peculiarities may be ascertained and allowed for. It is also a noteworthy proof that Mr. F. Siemens is working as actively and successfully as ever to improve the processes with which he has re-enforced the industry of the age.—*Journal of Gas Lighting.*

IMPROVED PROPELLER SHAFT.

THIS invention, by Mr. Arrowsmith, of Manchester, is intended to prevent damage to or loss of screw steam vessels in the case of the breaking of the propeller shaft. It is proposed to have a hollow driving shaft, containing an inner one. A is the hollow driving shaft; B, the inner shaft; C, disk to keep the inner shaft in place; D, solid shaft. The inner shaft is not to be keyed so as to bear any torsion, its duty being to keep a broken shaft in line, the broken shaft revolving with it. The inner shaft may be solid or hollow. Its most obvious and least expensive application is for a length next to the engines, and another in the stern of the vessel, extending through the stern tube. These parts have the greatest strain, and are, therefore, most liable to fracture. The extra cost of its application in a new vessel, or in replacing an old shaft, is small, when Messrs. Whitworth's shafts are adopted. Should the driving shaft break, setscrews can be inserted on each



side the fracture, and sufficient power transmitted through the inner shaft to drive the screw so as to keep pace with a vessel under sail, or even to propel it so as to give steerage way.

ELECTRIC TRAMCARS.*

By A. RECKENZAUN.

IT may be premature to read a paper on the subject of electric tramcars, considering that at this moment there is only one such car in existence in this country, as far as the author is aware; this solitary example, moreover, has only been in operation, experimentally, since October last, therefore the invitation of the council of this Institute was accepted with a considerable amount of hesitation.

The Inventors' Institute has a privilege before other societies in this respect, that it will judge of the merits of an invention as an invention, apart from the commercial aspect of the problem. Utility, however, is the first desideratum in an invention, and the author now submits to this Institute the bare question of utility.

Before going into the details of our subject, it may be interesting to dwell for a moment upon the figures given in this table, which was prepared in order to show what power a pair of horses are capable of exerting.

TABLE.

Power exerted by two horses in pulling a car with passengers, weighing 4½ tons. Tractive force, 30 lb. per ton.

At 7	miles	per hour	on level	road....	2·52	H.P.
" 6	"	"	"	"	2·16	"
" 6	"	"	gradient	1 in 75..	4·32	"
" 5	"	"	"	1 in 37..	5·4	"
" 4	"	"	"	1 in 37..	4·32	"
" 3	"	"	"	1 in 25..	4·32	"
" 4	"	"	"	1 in 25..	5·76	"
" 5	"	"	"	1 in 25..	7·2	"
" 3	"	"	"	1 in 18..	5·4	"

The additional power necessary to pull a car round curves cannot be ascertained with the same accuracy; it depends upon the radius of the curve, the amount of play in the axle boxes, and the size of the wheel flanges. A flexible wheel base will considerably facilitate the movement on curved roads, and wet rails offer less resistance than dry ones.

The force required to start a car and to get up speed is necessarily greater than the force required to maintain the speed uniformly. It is a variable quantity, says Mr. D. K. Clark in his admirable book on tramways, for it may be anything that horses choose to exert.

But it has been found by experiment that the momentary starting force is about four times the tractive force when once in motion; thus we may form a rough idea as to the exertion of a horse in starting a car on the level or on an incline.

Horses cannot tell us of their sufferings; we know merely that their life in tramway service is short, although they do not work longer than three to four hours a day. It seems barbarous to use horses as these figures show, still there has been no economical substitute until recently, and it is only within the last few years that mechanical traction has made any headway. That mechanical power will supersede animal power, and that at no distant date, is admitted on all hands, and the question of the kind of mechanical power to be employed is still an open one. It is often asked why so much mechanical power is required for the propulsion of tramcars, and why it is necessary that a tramway locomotive should be made to give as much as 40 indicated horse power, while two horses seem to do the same amount of work.

The above table shows what mechanical work is actually being done. James Watt ascertained experimentally that a strong dray horse was capable of producing a continuous effect of 33,000 foot pounds per minute, but we see that one tram horse does the work of three dray horses very frequently. When we now consider that a tramway steam locomotive weighs from 8 to 10 tons without the car and passengers, it becomes evident that the indicated H. P. just given is no extravagant measure. Take a locomotive engine, car, and passengers, weighing together 14 tons; in order to move that load on a level road with 30 lb. tractive force per ton, and at a speed of seven miles an hour, we require between 7 and 8 actual H. P., which is equivalent, after allowing for engine friction, to about 11 I. H. P., and in traveling up an incline of 1 in 37 this power will amount to something like 34 I. H. P.

Reducing our figures to a coefficient, and maintaining that the tractive force is 30 lb. per ton on a level but dirty road, we come to the conclusion that when moving at the rate of seven miles per hour on a straight line we consume in round numbers 8 foot pounds of work per minute for every pound weight on the rails; on an incline of 1 in 75 we consume 16 foot pounds, and on an incline of 1 in 37, 24 foot pounds for every pound weight carried at the same speed. Therefore, it is of the utmost importance to reduce the dead weight to be propelled to a minimum. When a locomotive engine has to drag the car behind it, it becomes necessary to provide weight in order to obtain good adhesion on the rails, and the best plan, no doubt, would be to utilize the weight of the car and passengers to furnish the requisite adhesion.

The number of steam locomotives employed on tramways is daily increasing, and steam traction is gaining in public favor. It is not within the range of this paper to examine into the advantages or disadvantages of steam traction, but merely to show whether electric cars have any chance of success from a utilitarian point of view.

We distinguish between the terms electric car and electric tramway or railway; the electric car carries its energy within, and it is quite independent of external influences, whereas with electric tramways the energy—electricity—is conveyed from the generating station to the rails or other conductors communicating with the motor which turns the car wheels.

Separate conductors are used by Messrs. Siemens and Traill at Giant's Causeway and elsewhere. Mr. Magnus Volk, at Brighton, conveys the current through the rails; the nature of the ground on the Brighton beach does not allow of any accumulation of wet and dirt; the rails are above the level, and there is no traffic across the line. An electric tramway is now being constructed at Blackpool, where the current of electricity is to be conveyed through conductors in a pipe laid underground; this pipe has a slot throughout the whole length to permit of the connection between the car motor and the conductor beneath the surface of the road.

Our electric tramcar requires no conducting medium; it does not interfere with the rails or roadway, nor with other traffic, can be readily shifted from one line to another of the same gauge, and it can be run in conjunction with the horse cars.

THE BATTERY.

The first requisite for an electric car is a battery which can be stowed away within the car. Such battery has to be of small weight; it must be reliable, supply any quantity of current, according to the requirements of the road, and it must be cheaper to maintain than horseflesh, and emit no smell. Primary batteries were out of the question; the cost of zinc and acids consumed in them would be much greater than the cost of animal power, independent of the difficulties attending the process of refilling such batteries when exhausted.

The invention of the secondary or storage battery put the question in an entirely new light. Certain successful laboratory experiments at once suggested the adaptability of this invention to the propulsion of vehicles. Four years have elapsed since the introduction of the Faure accumulator into this country; it caused quite a sensation at that time, and money could be found in abundance for the exploitation of anything that bore an electrical name. Things have changed entirely since then. The original Faure battery has never been of any practical service, and very substantial improvements had to be made, at enormous cost, to bring the secondary battery to a commercial value. The Electrical Power Storage Company have acquired the patent rights of M. Faure, in addition to those of Messrs. Sellon, Swan, and Volckmar, and they have, step by step, improved the mechanical details of these secondary batteries till they arrived, after fearful labors and expenses, at what may be termed a thoroughly practical article. But the

* Read before the Inventors' Institute, May, 1885. Mr. C. E. Spagnoletti, President of the Society of Telegraph Engineers and Electricians, in the chair.

prejudices created in the public mind by early failures have not quite worn off yet, and it will require something wonderful and startling to convince the public that the work of the last four years has produced remarkable improvements. None but those who have been intimately connected with the manufacture of storage batteries can form an idea as to the numerous difficulties which had to be surmounted before a permanent success was obtained. The battery was long ago perfect from a theoretical point of view, but it could not stand the test of time. Time was an essential factor; it took many months to test the durability of a set of cells, and it was only by close observation and careful remedying of defects, one by one as they appeared, that the storage battery assumed its present form—simple as it may appear to the uninitiated.

The cell before you is one of a set of the type specially designed for tramcar work. In a lead-lined strong teak box are placed 21 lead plates, weighing together 26 lb., inclusive of connecting strips and terminals; 10 of these are called positive and 11 negative. Each plate is formed of a lead grid, the perforations of which are filled with a paste of lead oxide; the positive plates contain red lead, which, in charging, is converted into peroxide, and the negative grids are filled with a paste of litharge, which, in charging, is reduced to spongy lead capable of absorbing hydrogen. We store, therefore, not electricity, but oxygen and hydrogen, which gases, by discharging the battery, manifest themselves externally in the form of electrical energy.

This box is filled with sulphuric acid and water at a specific gravity of about 1,150°; then a lid is put on, sealed all round the edges to prevent any spilling of acid. This acid is never removed so long as the battery lasts. There is no reduction of lead or any material going on within the cell, and the battery would last forever, but for the fact that the lead grid of the positive plates becomes so brittle with oxidation that it crumbles to pieces in the course of time; then these positive plates have to be replaced periodically by new ones, but the old lead is valuable. The life of a positive plate depends entirely upon the amount of work it has done. The plates in the box before you have been at work since September last year, and they are still in excellent condition; we should say they are still as good as new: they have frequently been discharged at the rate of 100 amperes, while the average working current is 46 amperes; these cells are always being charged at the rate of 32 amperes, and the storage capacity of a cell is 150 ampere hours. Sixty such cells will weigh 1¼ tons, and propel a car with 46 passengers for about two hours over a road with ordinary inclines, curves, and 60 stoppages per hour. The diagram represents a car which has been running at Millwall and at Battersea. The accumulators are placed on trays under the seats, out of sight. These trays can be drawn out through doors at one end of the car, and replaced speedily. A trolly containing a fresh set on trays and rollers is drawn up to the end of the car; the discharged cells are pulled out all together by means of a small winch, and the newly charged ones pushed in, when the car is ready to proceed on its journey.

There are three sets of accumulators to each car, two sets charging while one set propels the vehicle, thereby time is saved and waiting prevented.

THE ELECTRO-MOTOR.

This machine has to convert the electric current into mechanical power. For tramcar propulsion it is absolutely necessary that the motor should have a high efficiency and at the same time be of small dimensions and little weight. To combine these requirements has been the aim of the author, and he has at length produced a machine, shown on the diagram, which has had some rough tests in actual service under the most trying circumstances and conditions.

There are two motors driving the car, each capable of working up to nearly 9 horse-power, and weighing 420 lb. Each motor is supported independently upon a small bogy; the whole mechanism is self-contained, and each separated bogy forms a small locomotive engine, upon which the car rests. One axle of each bogy is a driving axle; thus we obtain four small driving wheels, which give requisite grip upon the rails. Either bogy can be detached from the car in less than one hour, so that in case of repairs and inspection the motor can be taken out and replaced without letting the whole car stand idle for any length of time.

THE GEARING.

The speed of the motors is necessarily high, about 1,000 revolutions when the car runs at seven miles per hour, thus it is necessary to introduce some mechanical reducing gear between the motor shaft and the driving axle. The gearing employed consists of a worm on each motor shaft and worm wheels on the driving axles giving a ratio of about 1 to 12. The worm gearing is boxed in, likewise the motor, and the wheels run in oil; dirt is thereby excluded and the lubrication is perfect. Easy access is obtained to the motors and lubricators through doors in the floor of the car.

VARIATION OF SPEED AND POWER.

This is obtained by means of a compound switch, which arranges the motor circuits so that the machines shall work in series, in parallel or singly, thus the resistance of the circuit being varied, the power and the speed vary accordingly. When a greater range of speed is desirable, the motor circuits are still further divided by arranging the field magnet wires apart from the armatures. This obviates cumbersome gearing, which would add to the weight and expense, increasing first cost as well as maintenance.

The driver has full command over the motive power; one handle suffices for all the operations of starting, stopping, and varying the speed or power. There is no useless electrical resistance, and therefore no waste of energy, whatever speed the car may be traveling at. The car is provided with these details at both ends, so that the driver has merely to remove the handles at the end of a journey, and two connections, and then proceed. It would be an easy matter to vary the speed by decreasing or increasing the number of cells, and thereby vary the electromotive force. This method, however, is injurious to the accumulators, because some of the cells would be discharged sooner than the others, and when they are all recharged in series, some would have to be very much overcharged before the rest could receive their share. There would not only be a waste of power occasioned by the evolution of gases for no purpose, but the life of the cells and their efficiency are reduced by this irregular treatment.

BRAKE POWER.

At each platform there is the usual vertical shaft and brake handle. A chain is wound upon this shaft, when the handle is turned, and eight brake blocks are simultaneously pressed against the corresponding number of wheels. The car can be stopped almost instantaneously. Besides this, there is an electrical brake, so that the motors act as dynamos driven by the momentum of the car, or by the car running down an incline; the whole of the power stored up in the momentum of the car is converted into electricity, and the current generated is utilized in magnetizing the brake blocks, thereby increasing their grip upon the wheel tires. Arrangements are being made to render this electric brake automatic, so that the main circuit will be broken and the brake circuit with the motors closed automatically when the speed of the car reaches a certain maximum.

COST OF MOTIVE POWER.

It has been mentioned that the capacity of the tramcar cells is 150 ampere hours; we do not exhaust them entirely, but leave a margin of at least 20 per cent. in the cells; 120 ampere hours' charge is sufficient to propel the car full of passengers for two hours, or about twelve miles, over an average road with frequent stoppages. When charging 60 cells at the rate of 32 amperes for four hours, and replacing the accumulators in the car every two hours, we require steam power to the amount of about 15 indicated horse-power per car. Assuming that the car has to run 72 miles in a day, and that we are supplying several cars at the same time from one engine, the fuel consumed need not exceed 4 lb. per I. H. P. per hour. The charging takes place during 12 hours of the day only, thus 7 cwt. of coal per car per day will give a consumption of about 10 lb. of coal per mile. Reckoning the price of coal at 18s. per ton, the fuel per car mile would cost less than one penny. By working longer hours we could do with smaller engines, but of course with the same consumption of coal per car mile. The most economical steam tramway locomotives burn from 9 lb. to 12 lb. of coal per mile, or about the same as quoted for the electric car. There are two reasons for this high consumption: first, the steam locomotive weighs four times as much as the accumulators and electric motor driving gear, therefore it requires greater power for its own propulsion; and, secondly, a tramway locomotive boiler and engine cannot be expected to compete with a large stationary engine and boiler as regards economy. Thus the loss arising from the conversion of steam power into electricity, and the reconversion of electricity into mechanical power, is more than compensated by corresponding advantages. There are instances where water power is available within a reasonable distance from the tramway depot, and in such instances the additional economy will be apparent.

PRIME COST, MAINTENANCE, AND DEPRECIATION.

The steam engines, boilers, dynamos, and shafting, and all necessary apparatus for a charging station to supply a dozen electric cars, including spare power, will cost £4,000; and the complete equipment of 12 two-horse cars, inclusive of ample spare gear, may be estimated at £6,000. The superintendence of machinery at the charging station will cost £1,100 per annum; fuel at 18s. the ton, water, oil, and waste, £1,400; 10 per cent. depreciation on engines, boilers, and dynamos, £400; and with an estimated depreciation of 35 per cent. on the whole propelling apparatus, we get a total expenditure of £5,000 per annum, which is equivalent to 3·5 pence per car mile run. You will observe that these figures are thoroughly reasonable, and allow of a good margin. We should have to almost annihilate the whole concern at the end of a year in order to bring the working costs to an amount allowed by some tramway companies for horsing.

The following is a summary of the principal points in favor of this system:

1. Economy in running cost.
2. The electric car has the same appearance as those in general use, and any ordinary car can be readily converted.
3. The wearing parts of the mechanism driving the wheels are few in number and easily replaced.
4. The weight of the motive power is less than 2 tons, distributed over two small bogies.
5. The propelling apparatus is invisible to the passengers, practically noiseless, clean, and free of danger.
6. One man (not necessarily skilled) can drive the car.
7. The car may be illuminated at night by the electric current sufficiently to enable the passengers to read comfortably. The power required to maintain the electric light is so small that the cost may be neglected from the estimates, for the lamps (giving together 40 candle-power) consume only 3 ampere hours out of 150 given by the cells.
8. The maintenance of the permanent way (paving) must be less than in the case of tramways where horses are used, the hoofs of which follow always in the same track.
9. The space required for a charging station for the secondary batteries is much less than that necessary for stables for horses to do the same work.
10. The same plant which charges the storage batteries may be utilized for lighting the depot, and even buildings in the neighborhood.

DISCUSSION.

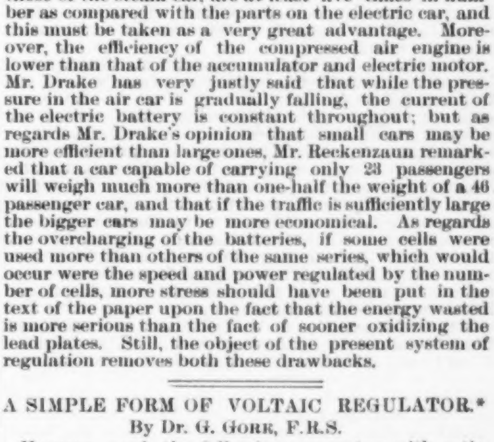
Prof. George Forbes, F.R.S.E., gave a short and concise account of the electric railways laid down in various parts of the world within the last few years, and he considered the methods of conveying the electricity through rails or other conductors clumsy and unsatisfactory. In Mr. Reckenzaun's tramcars they had no stationary engine connected with it by a conductor, and this he considered, other things being equal, a very great advantage. After the experiments made by M. Philippart with tramcars propelled by a Faure battery, he was glad to hear Mr. Reckenzaun say that storage batteries had at last been made commercially useful and practical. He now believed the difficulties which had encountered secondary battery makers in the past had been surmounted, and that the method of constructing them had been so enormously improved that those who used them were now masters of the situation instead of *vice versa*. Pointing to the battery exhibited on the table, the speaker said every one was struck with its light weight, which was brought about by its being made of thin plates, thus giving a large surface and a greater current than had ever been found before in a secondary battery. This he considered one of the chief things they had to be thankful for, because this bringing within a small compass sufficient power to last for a few hours had been their stumbling block in the past. He had been informed that it was impossible to overcharge these batteries, and that this could be done for months and months, but it is mentioned in this paper that this overcharging is detrimental to their working. The method of varying the speed and power devised by Mr. Reckenzaun is extremely ingenious and simple, avoiding the disadvantages of mechanical arrangements which would necessarily arise with numerous wheels, chains, or the like. As to the efficiency of electrically propelled cars as compared with other means of locomotion, he thought that although steam had made great progress of late years in the propulsion of tramcars, it still had very serious drawbacks, among which were that a small portable locomotive was far less economical than a stationary engine, especially as for the former they had to use a superior quality of fuel. Comparing the Scott-Moncrieff compressed air car with the one then under discussion, Prof. Forbes remarked that it seemed to him that the arguments which applied to one applied to the other, and also pointed out that in Mr. Reckenzaun's car they saw for the first time the application of a worm wheel to reduce the speed of the motor. In conclusion, he said it was satisfactory to hear that Mr. Reckenzaun was using electricity itself as a brake upon his car, because he thought that where electricity was applied as a motive power it ought also to be used as a brake power.

Mr. Reckenzaun, in reply, testified to the great pleasure and instruction he had derived from the observations of Prof. Forbes, Mr. Traill, and the other speakers, and that he felt highly encouraged by the remarks of such authorities. He pointed out that the comparisons made by Prof. Forbes between compressed air cars and electric cars do not hold good in all points, although there is a great similarity in principle. Compressed air cars are much heavier; the weight of the air reservoirs under the car and its engine cannot be less than four or five tons if made to run eight or nine miles with a pressure of 500 lb. to the square inch; the accumulators, motors, and gearing in the electric car weigh under two tons in order to propel the vehicle with 46 passengers over a distance of 12 to 14 miles, and the time occupied in changing the cells at the end of the journey need not occupy more than three minutes. The moving parts in the mechanism of the air car, like those of the steam car, are at least five times in number as compared with the parts on the electric car, and this must be taken as a very great advantage. Moreover, the efficiency of the compressed air engine is lower than that of the accumulator and electric motor. Mr. Drake has very justly said that while the pressure in the air car is gradually falling, the current of the electric battery is constant throughout; but as regards Mr. Drake's opinion that small cars may be more efficient than large ones, Mr. Reckenzaun remarked that a car capable of carrying only 23 passengers will weigh much more than one-half the weight of a 46 passenger car, and that if the traffic is sufficiently large the bigger cars may be more economical. As regards the overcharging of the batteries, if some cells were used more than others of the same series, which would occur were the speed and power regulated by the number of cells, more stress should have been put in the text of the paper upon the fact that the energy wasted is more serious than the fact of sooner oxidizing the lead plates. Still, the object of the present system of regulation removes both these drawbacks.

A SIMPLE FORM OF VOLTAIC REGULATOR.*

By Dr. G. Gore, F.R.S.

Having used the following apparatus with satisfactory results in a very large number of experiments,



in which comparatively feeble voltaic currents varying from about one-fiftieth to one-thousandth of an ampere were employed, I beg leave to describe it.

The construction and action of the instrument are indicated in the annexed sketch, but in order to adapt the apparatus to currents of the range of strength mentioned below, it is desirable to state the dimensions of some of its parts. A B are two glass tubes, about 2 cm. diameter and 10 cm. high, bent at right angles. Their upper ends are about 20 cm., and their lower ones 8 cm. apart; and the latter are united by a vulcanized India-rubber tube of their own diameter. The tubes are nearly filled with a three-fourths saturated solution of non-acidified cupric sulphate, in which are wholly immersed two electrodes of sheet copper, 8 cm. long and 1·5 cm. wide, the lower ends of which project some distance within the India-rubber tube. The tubes are supported by the baseboard, D, and the two wooden uprights, EF. By means of the wooden lever, G, which is about 2·5 cm. wide, and has a hinge at one end and a thumb-screw, H, at the other, the middle

* Read before the Birmingham Philosophical Society, June 11, 1885.

part of the vulcanized tube, resting upon a small block of wood, I, may be very gradually and strongly compressed.

With tubes and electrodes of the dimensions given, any strength of current ranging from 0·0001 to 0·05 ampere, may pass without interference of polarization; and, with a steady lever, a screw of slow motion, and the India-rubber tube slightly stretched, the current can easily be regulated to 1-100,000 of an ampere.

GLAESENER SECONDARY BATTERY.

All inventors—or rather devisers—of electrical accumulators or secondary batteries endeavor to obtain a maximum of surface with a minimum of weight in their electrodes. MM. Glaesener Freres, of Chatillon, near Arlon, in the Belgian province of Luxemburg, seek to attain this desideratum by rolling continuous bands or tapes of lead, having minute projections on both surfaces, so that, when wound spirally into a disk, they permit of the liquid passing freely between them.

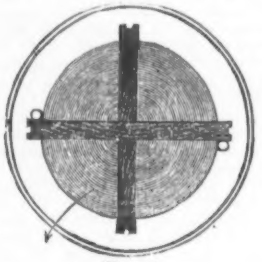


Fig. 1.

They assert that their accumulator is the lightest for a given duty of any hitherto brought out on the Continent. This battery has lately been brought into notice through its application to the lighting by Swan lamps of the Luxemburg prison, which will be referred to below.

The lead tapes forming the electrodes are 1 centimeter, or 0·4 in., wide, and about 0·4 of a millimeter thick, having on both sides small hemispherical projections, varying from 0·1 to 0·5 of a millimeter in diameter. Each tape, 30 meters, or nearly 100 ft., long, is wound spirally, so as to form a disk of 5 in. diameter, weighing 1,200 grammes, or 2 lb. 10 oz., and presenting an effective surface of, on an average, rather over 62 square decimeters, or six square feet 100 square inches. Although these electrodes are used without any coating, they lend themselves admirably to receiving a coat of red lead, which is held between the folds of the spiral. Besides, as soon as the accumulator begins to act, the red lead is held more closely, on account of the expansion of the electrode and the consequent tightening of the spirals.

The disks are arranged, as shown in the accompanying vertical and horizontal sections, in a pile of 11, with wooden crosses between, coated with a highly insulating varnish. To the bottom cross, which is stronger than the rest, are pinned four wooden uprights, which are attached to the cover, provided with a handle, so that the whole may be inserted and withdrawn from the glass jar, containing dilute sulphuric acid. The outer ends of the electrodes, arranged alternately positive and negative, as shown in the section, are wrapped round vertical lead rods, put in connection with the binding screws. An electrode has been sent to us which has been in use six hours a day for more than a year, and the lead of which, though brittle, is not eaten through.

MM. Glaesener Freres lighted their own works at Chatillon about two years ago with twenty 10 candle Swan lamps, maintained by 25 accumulators, the lead of each of which weighs 6 kilogrammes, or 13 lb. They are charged, from four to six hours a day, with a current of 55 amperes at 15 volts, and there has been no hitch hitherto. The next installation was at the Saint

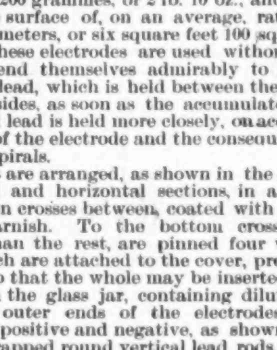


Fig. 2.

Leger Roller Flour Mill, which is driven by water, so that no additional expense was incurred for the power absorbed. A small Gramme dynamo charges forty accumulators, the lead of each of which weighs 18 kilogrammes, or about 40 lb.; and these maintain 16 Swan lamps. The installation cost, in round numbers, 1,500 fr. = £60; so that, putting 10 per cent. for interest and depreciation, and 50 fr. = £2 for maintenance and renewals, the expense of a year's lighting, for an average of 10 hours a night, is 200 fr. = £8, or 6 centimes (about a halfpenny) an hour. This is just the same price that was before paid for paraffin; but the lighting is now fifty per cent. better, without counting the diminished risk from fire.

The prison at Luxemburg is lighted by twenty-five 10 candle Swan lamps, distributed among the workshops, passages, and guard house, and maintained by 30 accumulators, the lead of each of which weighs 12 kilogrammes, or 26 lb. They are charged by a Gramme shunt dynamo, of the workshop type, giving out 70 to 80 volts at 21 amperes when making 1,500 revolutions a minute. A charge of 70 to 80 ampere hours is found sufficient for the lighting required, viz., a few hours every night, one lamp, however, being maintained all through the night. On one occasion, by way of trial, the accumulators, charged for an hour, by a current of 70 volts at 14 or 15 amperes, maintained a Swan lamp of 50 volts at 0·65 ampere for about 20 hours. The dynamo is driven by a broken-down old portable engine, the speed of which is so far from being constant that it certainly would not do for electric lighting, but for the accumulators acting as a regulator, and so maintaining a steady light.—*Electrician.*

ELECTRO-METALLURGY AT THE EXHIBITION OF ELECTRICITY.

The process of electro-metallurgy, invented in 1838 by Jacobi and Spencer almost concurrently, soon reached a high degree of perfection, and is to-day rendering great services. An enumeration of its applications would lead us too far from our subject, and so we shall merely point out its general principles as applied to the reproduction of works of art.

Of the art object to be reproduced, a hollow mould must first be taken. The substance almost always

Fig. 2.—GROUP FOR THE FACADE OF THE OPERA HOUSE, PARIS.

Fig. 1.—OBJECTS PRODUCED BY ELECTRO-METALLURGY.

used for moulding is gutta-percha, as this has the property of softening under the action of heat, so as to become plastic, and of afterward hardening again on cooling. For the majority of objects in high relief the mould is made in several parts, that are united after the interior has been metallized. The operation is as follows: If the object to be reproduced is sufficiently strong, a ball of gutta-percha, previously heated in boiling water, is strongly pressed against its surface by means of a special machine, so as to cause it to enter every part of the model and reproduce the minutest details of it. After cooling, the gutta-percha is separated. When the model is of clay or plaster, it is impossible to operate by mechanical pressure, as there would be danger of getting it out of shape or of breaking it. So the compressing is done by hand. The gutta-percha is heated over an open fire and brought to a high state of viscosity, and then spread by means of a spatula, and pressed down with the hand kept constantly wet with cold water.

These methods are simple and easily applied, but there has been a tendency for a few months past to substitute for them a new process due to Mr. Pellecat, counselor to the court of appeals of Rouen. Most of the objects exhibited by Christofle & Co. at the Observatory were moulded by this process (Fig. 1), the principle of which has been explained by Mr. Bouilhet in an interesting lecture. Mr. Pellecat's method is to heat the gutta-percha up to the melting point and then flow it over the object to be reproduced, without using pressure. He thus obtains great fineness of detail and a faithfulness of reproduction that would be demanded in vain of the processes formerly employed.

We must call especial attention to the fact that moulding by fusion in no wise submits the model to the risk of breakage or disfiguration, no matter how fragile it be. It permits, then, of a direct and perfect copy being made of the most valuable works. It will thus allow of the original models of our public collections being reproduced, and sent to provincial collections and to museums of decorative art. Finally, the process is better adapted than any other for reproduction in clay moulds.

Almost all the difficulties in moulding, whether by casting or electro-metallurgy, are due to the necessity of removing the model from the interior of the mould, this often leading to the necessity of dividing the latter into a large number of parts that afterward have to be united.

All such complications disappear in casting in moulds in which the wax model is destroyed. The model is fashioned in wax by the artist himself. This material is very tractable, and admirably adapted for rendering the smallest details. When the work is finished, it is covered with successive layers of a semi-liquid paste made of clay thinned with water or milk. This is applied with a brush, so as to cause it to penetrate every line in the wax. Each layer when dry is covered with another one, and the whole is then strengthened with plaster. After this, the mould is put into a stove, when the wax melts and flows out through holes formed at proper points. The casting of the metal, all in one piece, in this mould is afterward performed in the usual way.

This method was much employed in the period of the Renaissance, but is now almost entirely abandoned. Such a process evidently could not be applied to electro-metallurgy as long as pressure had to be used for taking an impression; but now, thanks to Mr. Pellecat, gutta-percha is spread with a brush as easily as the clay paste. More than this, it permits of operating upon clay models, and no longer necessitates the use of wax for modeling. Gutta-percha, in fact, is in no way altered by contact with cold water, while clay rapidly dissolves therein. By a prolonged immersion in water, then, followed by a washing, we can destroy the model, and remove all the clay through the vents.

FIG. 3.—DOOR FOR THE SAINT AUGUSTIN CHURCH.

Galvanic reproduction by this method is called upon to render great service to sculptors. The chances of loss are much less than by the wax method, while the artistic advantages are absolutely the same. We have here a genuine progress, which will prove equally favorable to electro-metallurgy and art.

But, to return to the series of operations embraced in electro-metallurgy. The mould being finished, it must be metallized, that is to say, be rendered a conductor of electricity in every part where a deposit is to be made. To this end, it is usually customary to employ powdered plumbago—an unctuous body that is a good conductor and that easily adheres to gutta-percha. The mould is then suspended in a galvanic bath consisting of a solution of sulphate of copper to which is added a little sulphuric acid. This solution is kept constantly saturated. The mould is connected with the negative pole of the generator of electricity, while the positive pole is attached to a plate of copper that constitutes a soluble electrode.

When it is a question of high relief, the problem to be solved is more complex. The different pieces that form the mould are metallized separately, and then assembled. Into the vessel thus formed is then poured the acidulated sulphate of copper solution, and the metallized part of the mould is put in communication with the negative pole, and the liquid with the positive. In order that the deposit shall distribute itself as evenly as possible, there is put into the mould a piece of metal called an anode, which approximately reproduces the internal relief, and directs the current to all the points to be covered, with a nearly equal intensity. This anode must not be soluble in the bath, for it cannot have much weight, and would therefore get used up before the deposit was sufficiently thick. Platinum was first employed for this purpose, but, upon the advice of Mr. Plante, lead, a less costly and but slightly soluble metal, was substituted for it. In this case the concentration of the bath is kept up through the addition of crystals of sulphate of copper.

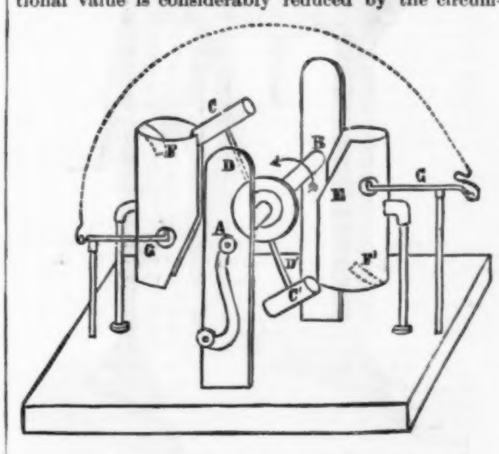
When, after a sufficient number of days, the galvanic deposit is of suitable thickness, the operation is discontinued, the mould is taken apart (if it is so arranged as to be taken apart), or removed by heat if in one piece (as in the Pellecat process), and the thing is done.

The generators of electricity employed in electro-metallurgy are usually piles, such as those of Daniell, Grove, etc. These have the advantage of operating alone, night and day, provided they are kept in a proper state by changing the liquid. But in large industrial establishments they are found to be costly, and so for several years past recourse has been had by Messrs. Christofle & Co. to continuous current Gramme machines. Although the use of piles for night was continued for a long time, it finally (after the exhibition of 1881) gave way to that of a powerful accumulator capable of furnishing a perfectly constant current of 25 amperes per hour for 13 consecutive hours. At present the troughs are charged during the day by a Gramme machine and at night by an accumulator. The results obtained are excellent. We give herewith (Figs. 2 and 3) a reproduction of two large electro-metallurgic works from the establishment of Christofle & Co.—*Science et Nature.*

A SIMPLE FORM OF INFLUENCE MACHINE.

By JULIUS ELSTER and HANS GEITEL.

INFLUENCE machines have found entrance everywhere as a means of instruction, on account of the undeniable advantages connected with the rapid production of great quantities of electricity. However, their educational value is considerably reduced by the circum-



stance that their theories offer the beginner considerable difficulties. To remove these, it is advisable before their introduction to show on a comprehensible apparatus the mutual re-enforcement of two conductors charged with opposite electricities.

For an understanding of the simple apparatus which we are about to describe, and which approaches in its construction Thomson's "replenisher," it is merely necessary to be acquainted with electric influence and with the fact that electricity has its seat on the surface of conductors. The arrangement of the apparatus is as follows: on the axle, A, B, turned by a crank, there are fixed six metallic conductors (the figure shows only two), C, C', made of corks covered with tinfoil. They are attached to the insulating supports, D, D', in a plane perpendicular to the axle. When revolving, these pass freely by two fixed insulated metal cylinders, E, E', open at both ends, which, in order to give a passsage to the supports, D, D', are cut open longitudinally on the side turned toward the axis of rotation. At the same time they are cut off obliquely on the side inclined toward the axis of rotation, at the parts at which the movable cylinders, C, C', issue in revolving in the direction of the arrow, in order, at the moment of emergence, to leave the greatest possible interval between the movable conductors, C, C', and the fixed ones, E, E'. These latter carry at the ends not cut obliquely two metal springs, F, F', turned inward, which project so far that they touch the movable conductors, C, C', when revolving. There also pass two other contact springs, G, G', through two circular apertures left in the fixed conductors (about the middle) into interior of these fixed conductors, where they likewise come in contact with the movable conductors. These two springs are in conductive connection with each other, or connected with the earth. The action of the apparatus is as follows:

Suppose that a certain charge, $+e$, is communicated to the cylinder, E. As soon as, on turning the axle, one of the movable conductors projects so far into the cylinder as to touch the conductive spring, G, it is rendered negatively electrical by induction; on revolving further, the spring, G, is first left behind; the conductor then, charged negatively, issues completely from the first cylinder, and touches the spring, F', of the second. It remains so long in contact with this until it has completely advanced into the interior of the cylinder, E', and has therefore given off its charge to it almost entirely. E' has now a negative charge. If the movable conductor now comes in contact with the spring, G', it is rendered positively electrical by induction, and on further rotation conveys its charge in the same manner to the cylinder, E, increasing its tension. So a mutual intensification of the charges proceeds

quickly as far as the attainable maximum. This cannot here be very high, since an efflux of opposite electricities very soon takes place from the springs, G, G', leading to the earth, as may be detected by the odor of ozone, and tufts of light visible in a darkened room. The apparatus is self-exciting. If two electric pendulums are fixed to E and E', the rapid increase of the charge is plainly perceptible.

Of course the apparatus would be considerably more efficient if, instead of the metal cylinder fixed radially to the axle, we used a revolving glass disk with sectors of tinfoil, and replaced E and E' each by two parallel glass plates coated externally with tinfoil. But then we should essentially return to the construction of Topler's machine, for evidently only a step is wanting to dispense with the charges of the solid conductors, E and E', and in their stead to introduce a spark interval in the metallic conduction of the two springs, G, G', which must now, of course, be insulated. If, finally, also the tinfoil sectors of the revolving disk are omitted, and if points are substituted for the contact-springs, we have the essential features of Holtz's construction. The connection thus indicated between the different forms of the influence machines has been already fully explained and theoretically founded in a treatise by Veltmann, "Theory of the Influence Machine,"* to which we refer.—*Annalen der Physik und Chemie; Electrical Review.*

HISTORIC ELECTRIC APPARATUS AT THE PHILADELPHIA EXHIBITION.

IN one corner of the Exhibition adjoining the lecture hall there was a collection of old apparatus borrowed

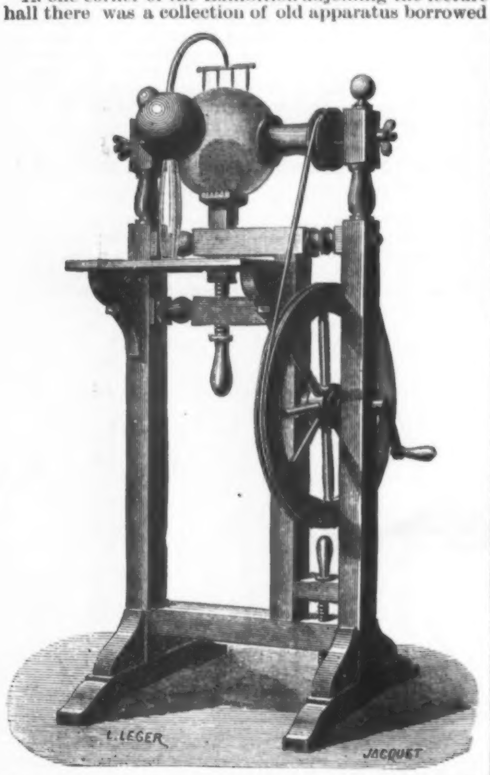


FIG. 1.—FRANKLIN'S ELECTRICAL MACHINE.

from the Patent Office at Washington. These models, which were quite numerous, were very rude, and it would prove tedious to enumerate them.

What was especially interesting was a small number of instruments of a scientific rather than of an industrial nature. First, there was the electrical machine which Franklin employed in his researches. Fig. 1, which gives a faithful portrait of this apparatus, needs no description.

Alongside of this there was a large and very interest-

FIG. 2.—PROF. HENRY'S ELECTRO-MAGNET.

ing electro-magnet, once the property of Joseph Henry. After the labors of Arago upon the magnetization of iron by a current, Sturgeon (in England) constructed an electro-magnet, but contented himself with winding a single layer of wire round a horseshoe-shaped core. As the wire was not covered with an insulating material, the spirals were somewhat distant, and such a magnet could not possibly be very powerful. It occurred to Henry to make use of silk-covered wire, and to wind this in several layers round the core. In this way he got a magnet that was much more powerful than any of those that had been made up to that time. He afterward studied the conditions that were necessary in order to obtain powerful electro-magnets, and was led to construct the apparatus shown in Fig. 2, which consists of a soft iron horseshoe suspended from a wooden frame. The winding of this core consists of a series of flat bobbins, whose extreme wires are so arranged that they can be grouped in several ways, and that grouping be determined in which the attraction is strongest. It is curious to see sectional electros dating back to so remote an epoch (1831).

* Veltmann, *Pogg. Annalen*, 151, p. 513, 1874.

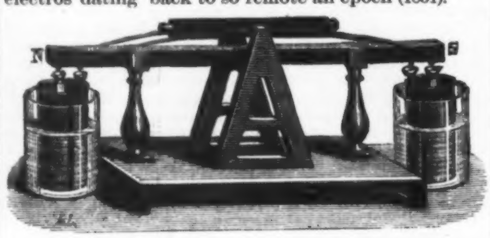


FIG. 3.—HENRY'S ELECTRIC MOTOR.

In the course of his researches upon electro-magnets, Henry likewise constructed the first electric motor that had been seen. The apparatus was, it is true, very rude, but it nevertheless demonstrated the possibility of producing motion by means of the electric current. It consisted (Fig. 3) of a magnetized bar placed in a fixed position. Above this there was a long electro magnet that projected beyond two pairs of wires that could dip into the mercury cups of two pile elements. If we suppose the electro to be inclined so that the wires of one side dip into the mercury cups of the pile to the left, the polarities will be such that there will be a repulsion to the left and an attraction to the right. The electro will then assume the opposite position, and the polarities be changed, and so on. There will thus be obtained an alternating motion.

But the apparatus exhibited were not the only interesting things. A search in the library revealed some curious works; we shall be content to cite Hare's Treatise upon Galvanism and Electricity. In this work we found a description of a motor (Fig. 4) formed of a permanent horseshoe magnet, between the

FIG. 4.—HARE'S ELECTRIC MOTOR.

branches of which there is a galvanometric helix. The continuity of the motion is secured by a commutator. In a word, we have here a Deprez motor without iron.

In this same volume we find electro-magnetic reversibility described. The experiment pointed out consists in revolving by hand a Ritchie motor connected with a galvanometer. The current produced is shown by the deflection of the magnetized needle. Will it be always possible to say, then, that "there is nothing new under the sun?"—*La Lumiere Electrique.*

APPLICATIONS OF ELECTRICITY TO MEDICINE.

THE interesting exhibit of apparatus by Dr. Boudet at the recent Electrical Exposition at the Paris Observatory merits special study. The application of the telephone to the auscultation of blood vessels is remarkable. This instrument not only permits of auscultating

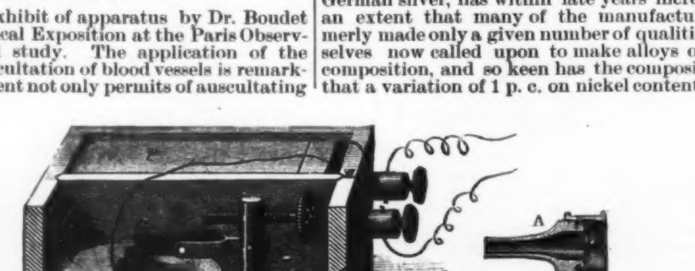


FIG. 1.—MICROPHONE FOR AUSCULTATION.

the pulsations of a blood vessel, but also of hearing all sorts of internal sounds. The apparatus as modified for this purpose is constructed as follows: The microphone system (Fig. 1), which is formed of two movable carbons, CC', with paper spring and regulating screw, M, is carried by a well stretched membrane, T, that covers a small drum whose interior is connected by a rubber tube with an exploring funnel, B. This latter is applied to the part to be auscultated, and the vibrations are transmitted by the air in the rubber tube to the membrane of the drum, which amplifies them, and converts them, through the microphone and a telephone receiver, into sonorous vibrations that may be very readily heard. A chloride of silver pile, P, suffices for the operation of the microphone.

Dr. Boudet has likewise constructed an apparatus that permits of transmitting sonorous vibrations to the teeth of deaf mutes, and has also applied the microphone (Fig. 2) to the detection of vesicular calculi, by adapting it to the handle of a metallic sound. In a lecture delivered at London, the Doctor asserted that he was able not only to assure himself of the presence or absence of a calculus in the bladder, but in nearly all cases to know its nature if present.

FIG. 2.—MICROPHONE FOR DETECTING CALCULI.

Dr. Boudet likewise uses the telephone as a measuring instrument for estimating in known and mathematical terms the nervous and muscular excitement in the different phases of a disease.

For dealing with occlusion of the intestines or with ileus, Dr. Boudet uses an intestinal exciter that permits of submitting the intestine to very intense currents without disorganizing the tissues. To this end, he employs a gum elastic sound provided with a hollow metallic handle connected with the canula of an irrigator filled with salt water. The current from the pile is transmitted to the salt water, which bathes the surface of the intestine over a wide surface. The other pole of the pile is connected with the loins or abdomen, according to circumstances, by means of a large disk covered with chamois skin. The current closes upon a circuit of very large section, and can occasion no disorganization, through excess of intensity, at any point whatever of the intestine. Out of 46 cases submitted to the treatment, 33 cures of occlusion have been effected.

In the case just examined, the current is distributed over a very wide surface. In other cases (for example

FIG. 3.—EXCITERS.

when the brain is operated upon), all derivation may exert an injurious influence. To avoid this, concentric exciters (Fig. 3) are employed, and the form of which may be varied *ad infinitum*, according to the effects to be obtained and the part of the body to which they are to be applied.—*Le Genie Civil.*

A NEW AND RAPID METHOD OF GERMAN SILVER ANALYSIS.

By THOMAS MOORE.

THE manufacture of copper, nickel, and zinc alloys, generally classified under the comprehensive title of German silver, has within late years increased to such an extent that many of the manufacturers who formerly made only a given number of qualities find themselves now called upon to make alloys of very exact composition, and so keen has the composition become that a variation of 1 p. c. on nickel contents would now scarcely be tolerated. One obvious result of this competition is that the analysis of the alloy has become more the rule than the exception, and as time is an important factor, I venture to hope the under-noted process will prove useful to those engaged in such analysis. Hitherto, the only difficulty in German silver analysis was the separation of the zinc from the nickel, but now, thanks to Zimmermann's ammonic sulphocyanide method, this has almost disappeared, and were it not for the introduction of ammonic salts into the nickel

solution, the process would be all that could be desired.

The following is the process I employ, which includes a zinc from nickel separation, which, I think, is quite new, and is also very accurate, and also a new way of dissolving the copper sulphide, by means of which a considerable saving in time is effected.

Dissolve 0·5 grm. of the alloy in *aqua regia*, and evaporate to dryness over the water bath; to the dried residue add 25 c. c. hydrochloric acid, sp. gr. 1·160, dilute to 250 c. c. with distilled water, keep the solution at 70° C., and precipitate the copper with sulphureted hydrogen; filter, and wash out with hydrochloric acid, sp. gr. 1·05, which is saturated with sulphureted hydrogen and then with water containing that gas in solution; by so proceeding, a second precipitation is thus avoided (Gerh. Larsen); wash the precipitate into a beaker glass, and dissolve it by adding potassic cyanide. Heat facilitates the solution, which takes place in a few seconds, and do not use more cyanide than is necessary to effect the complete solution, except perhaps a small black insoluble residue of plumbic sulphide or a yellowish powder of separated sulphur. Add to the solution so obtained 20 c. c. of a strong solution of ammonic carbonate, and dilute to about 250 c. c.; boil for a minute or two, and submit the solution to electrolysis, keeping it about 70° C. and occasionally adding a little of the carbonate solution. I use three Bunsen's cells, pint size, and find that from two to three hours are amply sufficient for the complete deposition. The deposited copper has a brilliant and compact appearance, and is dried and weighed in the usual manner.

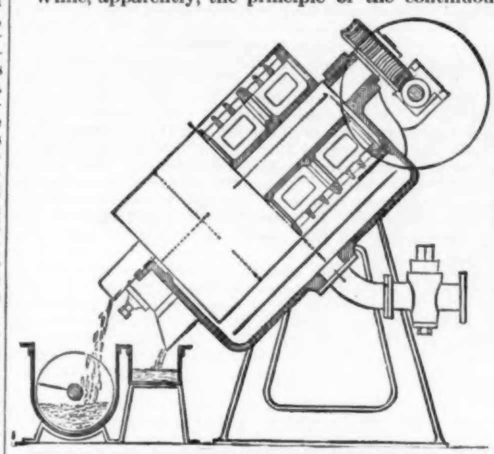
The filtrate from the copper precipitate is evaporated to dryness, the residue dissolved in water, and sufficient pure potassic cyanide added to dissolve the precipitate first formed. Any iron present will be left partially undissolved, but that will not influence the results. Wash the solution into a flask of 600 c. c. capacity, and add colorless or but slightly colored ammonic sulphide (not the yellow sulphide); dilute to about 400 c. c., place a funnel in the mouth of the flask and a spiral of platinum wire in the flask to prevent bumping; boil until the steam has no action on test papers. A double decomposition takes place, ammonic cyanide is volatilized, while zinc sulphide is precipitated, which is filtered off and washed with boiling water containing sufficient sodic carbonate to make it distinctly alkaline. The filtration of the precipitate so obtained does not present the slightest difficulty, the sodic carbonate preventing any of the sulphide passing through the paper, which, when well washed out, is dissolved and converted into the carbonate and weighed as oxide in the usual manner. If any iron is present, separate from the weighed oxide by repeated solution and precipitation with hydrochloric acid and ammonia, and add it to the other portion of the iron separated from the nickel solution.

The filtrate containing the nickel is acidified with hydochloric acid, and digested in a warm place with bromine until a clear solution is obtained; or evaporate to dryness with *aqua regia*, and precipitate the solution obtained by either method with potassic hydrate and bromine, filter off the black precipitate, wash well and dissolve off the filter with dilute sulphuric acid, add excess of ammonia, and electrolyze hot. Any iron which separates out, filter off and weigh.
—*Chemical News.*

PRESSES FOR BEET ROOTS, ETC.

During the early stages of beet sugar making, hydraulic pressure was the only means of extracting the juice. Strange as it may seem, there are but few factories at present using this costly method. Continuous presses were, for many years, greatly in vogue, the idea of their use being evidently suggested by the cane-crushing mills. The most important presses are Lebee, Champonnois, Poizot, Socin, Collette, Dujardin, etc.; a few of these only will be described.

While, apparently, the principle of the continuous



TRANSVERSE SECTION OF CHAMPONNOIS PRESS.

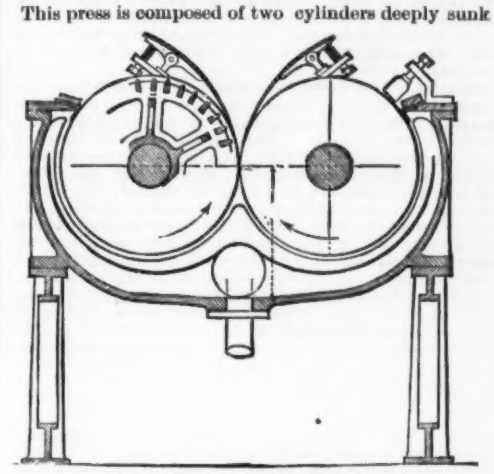
press is excellent, we regret to say their life has been short; not due so much to the loss of sugar in the pulp, for in that respect there was improvement over the hydraulic presses, but to trouble of working the extracted juices. These contained impurities, such as gums, etc., most difficult to eliminate in processes of purification.

LEBEE'S CONTINUOUS PRESS.

The Lebee press is said to combine the advantages of the Champonnois and some others. While it had considerable popularity at one time, it is now seldom used. The pulp from rasps is forced into chamber, B, of the press through the pipes, C C′. The filtering, revolving cylinders, A A′, then press the pulp, which continues moving forward under the solid cylinder, F and A′, thence between A′ and I and M and A″; finally has exit at side of the apparatus. The resulting juice flows from the pipes, D and O. Each filtering cylinder, when properly arranged, has about 5,000 blades. The advantage over the Champonnois press is that, if at any time a portion of the filtering surface should need repairs, it may be done in a short time by unscrewing the plates holding the blades in place. About 50 tons beets may be pressed with this apparatus in 24 hours; the cost of repairs is about 75 cents per week.

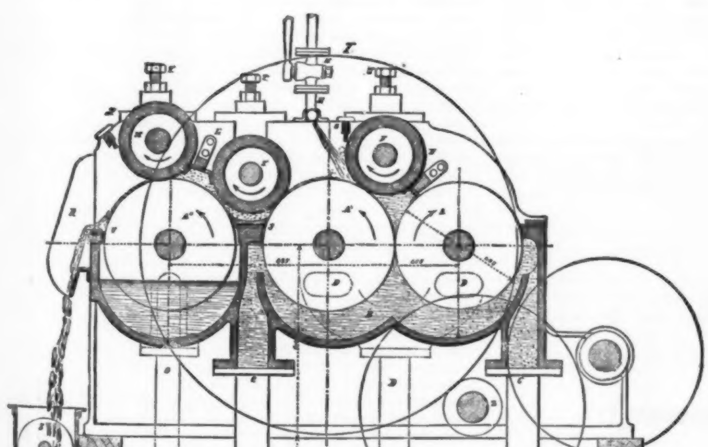
CHAMPONNOIS PRESS.

This press is composed of two cylinders deeply sunk

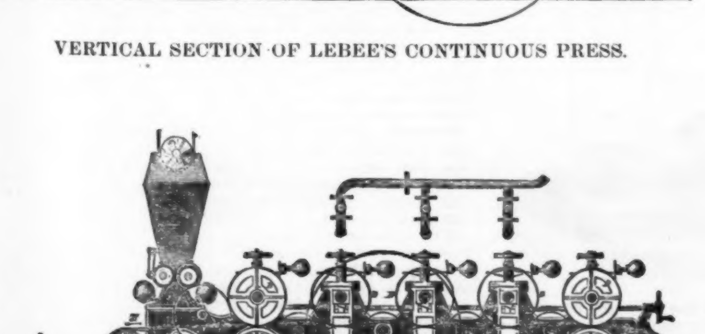


END SECTION OF CHAMPONNOIS PRESS.

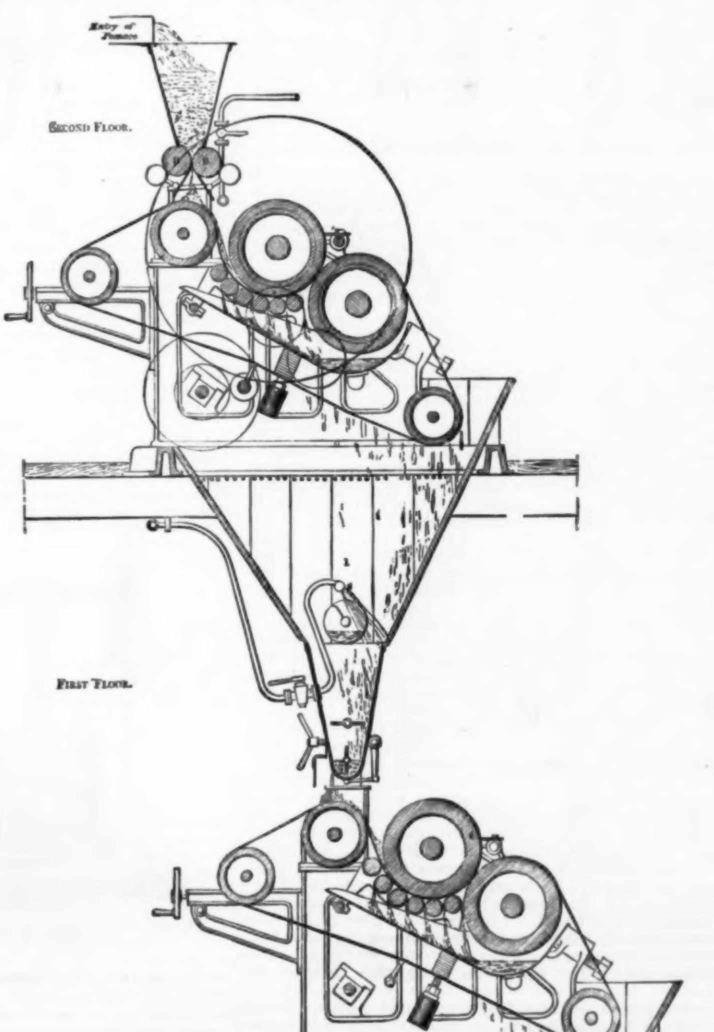
into the frame of the apparatus, and revolving in opposite directions, receiving movement from a well arranged gearing placed above. The cylinders are inclined at an angle of 45°, and are covered with a spiral wrapping of triangular wire. A special device is adopted to prevent the stretching of the wire. The pulp is forced into the lower part of the press by a special pump connecting with the rasp, and at a pressure of two atmospheres. Upon entering, the pulp is forced on both sides into the open space, and subsequently between the rollers; the juice passes through the spaces in their peripheries, and flows from the apparatus. The rolled pulp is scraped from the cylinders by two blades, shown in engraving, and falls into a receptacle, from which it is at times removed. About 50 tons pulp may be worked by the Champonnois press in twenty-four hours.



VERTICAL SECTION OF LEBEE'S CONTINUOUS PRESS.



SOCIN'S CONTINUOUS PRESS.



THE POIZOT PRESS.

POIZOT CONTINUOUS PRESS.

The press of the Poizot type we saw working and giving considerable satisfaction at Flavy le Martel, France. The arrangement existing there was very much the same as shown in the engraving herewith. The first pressing was accomplished on an upper floor, while directly beneath was placed an apparatus of the same type, but used for second pressing. The Poizot press is composed of two cylinders having parallel axes, but not on the same plane (level). They are one above the other, but not directly so, and consequently the lower roller is somewhat more forward than the upper one. The rollers are of hollow iron covered with ½ inch of rubber.

Around the cylinders—beneath one and above the other—is an apron of coarse woolen fabric, on which the pulp falls after leaving the two rollers, B, directly beneath the hopper. The apron, before running beneath the upper cylinder, passes over two wooden cylinders, shown in engraving; the axes of the latter are movable, the object being to tighten the apron when it becomes stretched; with this exception all the rollers are stationary. When the apron passes beneath the upper roller, it is guided by several small rollers, shown in drawing, and the juice, after filtering through to the apron, flows into a special, inclined, metallic receptacle. A portion of the compressed pulp adhering falls into the large wooden hopper below, but what pulp remains is knocked off by a special device, and the apron finally returns to starting point, entirely free from residuum. The lower part of the wooden hopper is connected with a small pipe conducting water to sprinkle the pressed pulp of the previous operation. The diluted pulp then runs upon the cylinder of second press, and the weak juice is separated and passes into a reservoir, from which it supplies the rasp. The cost of working the Poizot press, in France, is said to be ten cents per ton of beets. It is capable of furnishing 600 hectoliters* of juice per 24 hours; but one of the great difficulties seems to be to obtain woolen aprons of proper quality.

SOCIN'S PRESS.

This press is said to give satisfactory results. The pulp falls into the hopper, A, and thence on a moving porous apron, B, which is run through five pairs of rollers. The distance between the rollers, D and E, may be exactly regulated, and the juice flows through the rollers, E, which are perforated for that purpose. Over the rollers, D, is placed a series of scrapers which throw the adhering pulp on an apron. It is found desirable, at regular intervals, to sprinkle the cylinders with water; this is accomplished by suitably arranged cocks and pipes, shown in the upper part of engraving. Satisfactory working of the Socin press requires that at least three such apparatus should be used, two for first pressing and one for second. The pressed pulp from first pressing is mixed with water previous to second pressing. The advantage of this press is the elimination of pulp from the juices, by filtration through the flaxen apron. About 80 tons beet pulp may be pressed per 24 hours. Juices of second pressing are used on the rasp, previously described.—*The Sugar Beet.*

BENJAMIN DAY'S SHADING MEDIUMS.

AN invention to which we wish to direct attention, and which has become of paramount importance to lithographers, is Day's method of stippling and otherwise shading drawings on stone, zinc, etc., by means of his shading mediums. This invention is simplicity itself, and yet, simple as it is, the results obtained are marvelous, and the rapidity with which a drawing can be perfected by its use will at once be realized by the artist.

Imagine a relief plate, or a type of any particular stipple, line, tint, or other texture, as thin as the paper on which the *Lithographer and Printer* is printed. The thickness is only that required by the relief of the particular texture on the printing face of the film, and it is astonishing, when we think of it, that the $\frac{1}{1000}$ of an inch is all the depth required for most of the tints. This printing plate, for so we must call it, has a smooth face on its upper side, with the tint or texture in relief on its under side. The upper side is comparatively rigid, while the printing face is just elastic enough to yield a clear, sharp impression when the upper side is rubbed with a burnisher or other rubbing instrument. The whole printing plate, or film, as the inventor calls it, is perfectly transparent, even when inked, and the work and offset outline can be seen distinctly through it, as can the printed tint when rubbed down on the stone. This printing plate is mounted on a light frame, which keeps it taut and flat, and the whole is hinged to a movable bar, by means of which the film can be readily placed over any part of the drawing on any sized stone and adjusted to its level with nicety. The hinges are so arranged that the film can be removed, inked freshly, and replaced in exactly its former position, so that the texture will register to a hair; and, by a very simple mechanical device, when a deeper tone of the same texture is desired, the film can be thrown slightly out of register, and a line can be thickened, or a dot increased in size, by printing the same line or dot side by side with and so close to the one previously printed that it has the look of a differently sized line or dot. By these means cloud effects, shadings on drapery, flesh, and on other portions of the drawing, can be modeled rapidly and beautifully. The film is inked with a type-printer's glue roller, and, when properly inked, the impression on the stone is as clear and sharp as the finest of prints on paper. It is obvious that a direct print on stone with transfer ink must be shaper and clearer than a transfer from a printed proof, and that the stone must secure a larger charge of flat ink; hence, the work, if properly printed on the stone, should hold as well as the portions of the drawing made in tushe, and we found it impossible in specimens shown us to pick out the hand work from the machine work, especially where imitation hand textures were used.

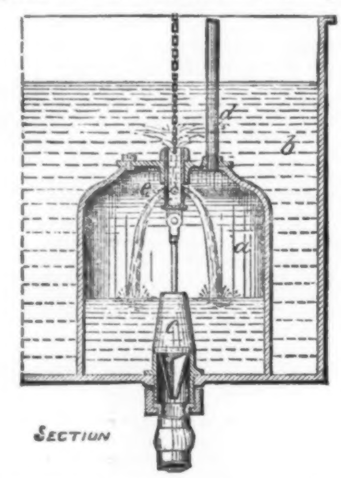
The mechanical tints, such as rulings and square stipples, could, of course, be picked out, as no artist could possibly equal them, and we feel certain that it would take a pretty clever one to draw or stipple in an effect such as can be produced by a combination of these various textures.

In chromo work, variety of texture is quite as necessary as variety of color and tone. The shading medium puts it within the power of an artist of intelligence to give each piece of work a *cachet* or stamp peculiarly its own, and to produce, with a less number of printings, effects which usually require more by the ordinary means.

Mr. Binger, of the firm of Emrick & Binger, Haarlem, in Holland, has long practiced the method of working up each color for all it is worth, and by so doing has saved in the number of printings. He has found Day's method indispensable for the furtherance of this end, as, by the fine subdivision of the texture in each color, he can obtain tone qualities more brilliant than those obtained by the piling up of print on print, as is usual in most lithographic houses. Day's textures have all a positive printing face, and hence the print on stone has a positive, visible ink-taking surface, which insures regularity in the appearance of the edition. On a recent trip to New York we visited Day's studio, 32 Beekman St., and were shown through the establishment. We were surprised at the number of handlings that such a simple looking thing as a film went through before it is ready for the artist's use. It is first moulded and allowed to dry thoroughly in the mould, then proved and examined for imperfections; if perfect, it receives its backing, is dried again, and then mounted with a cloth border on a drying or seasoning frame, on which it is kept for weeks in an airy place, until the particles have assumed their permanent place, and there is no further shrinkage. It is then moulded and placed in its case, and packed away for next year's use. Mr. Day never sends out a film that has not been in stock a year.

WATER-WASTE PREVENTER.

THE accompanying sketch shows a novel water-waste preventer intended for the flushing of water-



closets and other fixtures. It is composed essentially of a cistern, *b*, within which is fixed a submerged subsidiary chamber, *a*, in the bottom there is the usual weighted valve, *c*, and above which, on the same direct connection, is the special valve, *e*, which interrupts the connection between the chambers, *a* and *b*, at the times when the flushing-valve, *c*, is open. The pipe, *d*, is to admit the egress and ingress of air as the chamber, *a*, fills or empties.

It is claimed that this arrangement is noiseless, and that contamination of the water in the primary receptacle cannot take place. The manufacturers are Messrs. Hayward, Tyler & Co., of Whitecross Street, London, England.

BALANCE FOR CANDLES.

DR. KRUSS, of Hamburg, describes in the *Gas Light Journal* a balance for candles that he has constructed, at the instance of Dr. Lamousky, for the committee

which controls the lighting of the city of St. Petersburg. In this apparatus an acoustic signal makes itself heard, as in the Dumas and Regnault photometer, every time the balance passes through its point of equilibrium. The apparatus is shown in the annexed figure.

The length of the two arms is in the ratio of 1 to 2. The candles are attached to the shorter arm, whence it results that their vertical motion is but slight, and that, when once properly placed, their rays fall upon the photometer nearly at right angles therewith. The candle support, A, is capable of sliding along the rod, B. The current starts from the pile in the box, C, and traverses the electro-magnet of the bell, G, the body of the balance, and the needle, Z. The other pole is connected with a small lever, H, which can be kept fixed in two different positions. In one of these latter the lever allows the needle to pass without making a contact; and in the other the needle touches the lever just at the moment at which it is passing through the point of equilibrium. In this latter position the bell begins to vibrate. The circuit can, moreover, be broken at any moment whatever. A Wolff dry pile serves as a source for the current. Experiment has proved that this pile is capable of operating for years without requiring refilling.

In order to use the apparatus, the beam is balanced by placing weights in the pan, F. After this the candles are lighted, and upon the pan, E, there is placed an additional small weight, so that the needle, Z, shall move slightly to the right. If the circuit be now closed, the bell will begin to vibrate at the moment the needle touches the lever, H. From this moment, the photometric experimentation begins, and we measure the quantity of gas necessary for the supply of the burner. When the bell has sounded, we place upon the pan, E, a small weight whose size depends upon the desired duration of the experiment. We thus break the contact between Z and H, and such contact is not established again until the weight of the candles has diminished to a degree that is equal to the weight added to the pan, E.—*La Lumiere Electrique.*

ECONOMICAL AND FIREPROOF PLASTERING.

By G. H. HUNT.

To quote from "Notes on Building Construction," "Plastering consists of applying different compositions, resembling mortar, to walls and ceilings in thin layers, so as to form smooth surfaces for the sake of appearance and cleanliness." This would be rather too brief a description with which to sum up the plasterer's trade, but it is sufficient for our purpose, and may stand as a preface to the paper we are writing; not so much with the object of describing the different materials and processes of plastering now in use as to introduce to architects, builders, plasterers, and others interested in building operations a new material, "Robinson's cement," recently invented, patented, and brought upon the market by Messrs. Joseph Robinson and Co., of the Knothill Cement and Plaster Works, near Carlisle. This cement will, we feel sure, be a welcome addition, not only to the plasterer, but to his employers.

It is so good, so true, and uniform in its manufacture, so economical and efficient in its working, and may be used for such a variety of purposes, that we believe it only requires to be sufficiently known to come into very general operation. We are convinced, after a long series of experiments and tests, of its great utility and efficiency as a substitute for any of the cements now in use; and from its cheapness it is likely, when known, to very generally take the place of the present mode of plastering, entirely altering for the better the character of the work about our buildings in this very important respect. So many improvements have been made in building materials and appliances of recent years, the artistic knowledge and requirements of the present time have so much increased on the part of architects, builders, and their cilents, that to be contented any longer with the plastering as it is at present done in the general way is hardly possible. It is not only tedious and clumsy in its preparation and application, but often imperfect in its result.

The plasterer's pit taking up so much room about a building, and for such a length of time, for the proper slaking of the lime, is a positive nuisance, and a change in this direction is not only desirable but requisite, particularly where, as in towns, the space around building operations is limited, and in these days of rapid progress expedition in carrying out the works is so essential. These considerations, among others, have led Messrs. Robinson and Co. (or rather the head of the firm) to devote much time and attention to the invention of a cement that should obviate all this, by being equal in all respects to the Keene's, Parian, or other cements now used (but in limited quantities, and in the best class of work only, to which they are confined by reason of their cost), and at the same time so much cheaper that it might be introduced and used not only as they are, but as a substitute for the ordinary plastering, consisting of lime, sand, and hair, that we have hitherto been compelled to put with.

This result they now claim to have obtained by means of their new invention, and they reasonably hope that their cement may be given a fair trial, feeling assured that it will give every satisfaction, either when used in lieu of Keene's or Parian, or as a substitute for ordinary plastering. Before more fully describing "Robinson's cement," it may be as well briefly to glance at the ordinary methods of plastering in general use, as it will enable us to make comparisons that may assist us in arriving at a fair decision upon this new material. In the ordinary methods of plastering familiar to most of us, the materials used are lime, hair, and sand mixed together, and laid on in successive coats, differing from one another in their preparation in accordance with the character of the work. Pure, or fat, limes are generally used, for the sake of economy and safety; hydraulic limes requiring especial attention to prevent them from blowing. The lime should be most thoroughly slaked, or it will throw out blisters after being spread; for this reason the "stuff" is made long before it is required, and left for weeks to cool, *i. e.*, to become thoroughly slaked.

The different preparations made in this way are the "coarse stuff," "fine stuff," and "plasterer's putty." "Coarse stuff" consists of one or one and a half parts of sand to one of slaked lime; the sand is heaped round in a circle, and the lime, previously mixed with water to a creamy consistency, is poured into the middle, hair is then added and well worked in to make the coarse stuff hang together, and the mixture is left several weeks to cool. "Fine stuff" is pure lime slaked to a paste with a small quantity of water, afterward more water is added till it is of the consistence of cream, it is then allowed to settle and the water run off, that in the mass allowed to evaporate until the whole has become thick enough for use. "Plasterer's putty" is similar to "fine stuff," only prepared more carefully and run through a sieve.

Taking the ordinary three-coat work, usually specified as "plaster float and set," as an example. The first coat, or "pricking up," for ceilings or partitions consists of a layer of the "coarse stuff" spread over the

* A hectoliter = 26 gallons.

laths, stiff enough to hold together, but sufficiently soft to pass between the lath and form a key; it is then scored over with the points of laths to form a key for the second coat or floating, which is applied when the pricking up is sufficiently dry, and consists of "fine stuff" with the addition of a little hair, and is laid on with floats, worked upon screeds of plaster, to insure the surface being true; this is then gone over with a hand float, any defects made good, and allowed to become perfectly dry. Then comes the third or setting coat. If the surface is to be papered, it should be set with "fine stuff," and if whitened, with "putty" and washed sand, and if painted it should be finished "troweled stucco," composed of two-thirds "fine stuff," without hair and one-third fine clean sand. If it is required to set very quickly, especially in damp weather, one-sixth to one-third plaster of Paris is added to the "stuff," and is termed "gauge work;" it can only be mixed in small quantities, and great care must be observed that the other coats are perfectly dry, or, the shrinkage being unequal, the last coat will be full of cracks.

Rendering is the term when the plastering is applied to walls; it is done in the same way as before described, but not so much hair is required in the "coarse stuff" as when used on laths. With the results as thus worked out we are all pretty well acquainted, but are not all equally satisfied. It has hitherto, for the want of a better, and not much more costly, material been considered sufficiently good in the ordinary way to meet our requirements; but how often have we found by pricking the surface that the under coats run out like dust, indicating their soft and unsound quality. Then the blistering that often takes place over the surface, although so much time and care have been spent in the endeavor to slake every particle of lime; and again there is the cracked surface too often seen, rendering it necessary to apply some other material, such as paper, to hide its defects. We submit that this is no longer sufficiently good, when the other fittings and finishings of our dwellings are so much improved in design, material, and workmanship, if the desired end can be obtained at a trifling additional cost over ordinary plastering, as we believe it may be by using "Robinson's cement" This can be applied as Keene's or Parian now is, giving equally good, if not even better, results, and by reason of its cheapness may be substituted for general plastering, making good work in this respect the rule, instead of the exception, as at present.

The additional cost in the material itself we think likely to be pretty well counterbalanced by the saving in space, time, and labor in working "Robinson's cement." The plasterers' pit, and the time occupied in slaking the lime and waiting for the drying of one coat before another can be applied, will be no longer required, the carrying of the "suff" from where it is prepared to the spot where it is wanted would be obviated, the cement being mixed where used with the requisite quantity of sand applied at once in one coat and finished off as desired there and then, forming one homogeneous body, without any delay arising from the dampness of the weather or any other cause. Messrs. Joseph Robinson & Co., the patentees and manufacturers of this new cement, have been established since the year 1828. Their principal plaster and cement works are situated at Knothill, near Carlisle, where they have immense deposits of the purest alabaster. They have also extensive quarries in Westmoreland and in Staffordshire. Their Knothill works are directly connected with the Midland Railway system, the Midland Company having built the Cotehill Station specially for their extensive traffic, and laid down slidings in connection with the works. The quarries situated in Inglewood Forest, from which they obtain their best alabaster, are practically inexhaustible, and are in first-rate working order. The uncovering, though considerable, requires no mining, the average depth of the face of the alabaster when uncovered being from 20 to 30 ft.

Very large quantities of the alabaster are now bared, ready for use, the principle here being to keep well ahead in this respect, in case of any unusual demand. The alabaster in these quarries in its original state is almost pure white, and as compared with alabaster generally it is peculiarly hard, which is a great point in its favor, for the harder the nature of the raw material, the better the quality of the cement and its strength in setting after manufacture. Coal is cheap in the neighborhood, and the direct communication with the Midland Railway simplifies the getting it and sending away of manufactured articles. Messrs. Robinson & Co. make their plasters and cements where the raw material is produced, thus reducing their working expenses to a minimum, and enabling them to compete favorably with any other manufacturers equally well placed. Hitherto for many years they have confined their attention principally to the manufacture of plaster of Paris, in its various forms; but having now perfected a cement so likely to come into extensive use, they are making every preparation needful to insure their meeting a large demand by erecting the additional necessary machinery. The manufacture of this new cement is simple, uniform, and expeditious in the extreme, compared with that of other cements of similar character, which are not only complicated, but so slow and tedious that a long time is required in their manufacture. As an example of the expedition with which "Robinson's" can be manufactured, we may mention that by way of a trial they have on receiving an order by the morning's post taken the alabaster out of the quarries, converted it into cement, and sent it off by rail the same afternoon. This means, of course, a great saving in the cost of manufacture, and enables them to offer their cement at a price which, together with its very greatly increased power of carrying sand, makes it possible of introduction for general plastering work. In perfecting this cement many experiments have been tried and the results very carefully tested. These tests have been in operation over several of the winter months, and are most satisfactory. A short description of some of these tests may be useful.

TESTS.

A bay of a brick wall, a yard wide by two yards high, was covered with the ordinary three coats, "render, float, and set work," for the sake of comparison; next to this and subject to exactly the same influences, and in similar sized pieces, were some five or six slabs of "Robinson's" cement work done by an ordinary plasterer as follows:

1. The rendering coat, averaging five-eighths of an inch thick, consisted of two parts sand to one of cement, set directly sufficiently hard to be finished with a rough surface of equal parts of sand and cement, and in the space of a few hours was particularly hard and strong, equal in this respect to Portland.

2. The second slab was in the proportion of three parts of sand to one of cement for the rendering coat, of the same thickness as before, and was finished directly with pure cement one-eighth of an inch thick. This in a few hours also set very hard, and its strength became very considerable.

3. The third slab had four parts of sand to one of cement for the rendering five-eighths of an inch thick, and finished with pure cement. This also set very hard and strong, worked easily, and stands admirably.

After an interval of several months, there is no sign whatever of deterioration in any of these examples; but, on the contrary, they have hardened with time, which is a conclusive proof of the quality and strength of this cement.

4. Several other mixtures of the sand and cement were tried at the same time for rendering coats five to one and even six to one. With this very large proportion of sand the result was considerably stronger than the ordinary rendering of lime, sand, and hair; but for general work the proportion of "four of sand to one of cement is recommended." The quantity of sand this cement will carry is greatly in excess of other similar cements, and proves its natural strength and economy in use.

On laths for ceilings or partitions it was tried in the first instance pure, averaging three-quarters of an inch thick, including the key. There was very little waste on putting it up; it formed a good key to the laths, and in the space of a rew hours set so strongly that it became extremely difficult to break it away, even with hard hammering.

5. It was next tried for similar work with two parts of sand to one of cement, with a very little hair added for the first or pricking up coat, and then finished with pure cement one-eighth of an inch thick; this made excellent work, and in pricking up there was little or no waste.

Its resistance to fire was also tried in several different ways. It stood the tests applied, and proved its excellent fireproof qualities; for casing wood and iron work it will be found very valuable, and also for forming a fireproof ceiling. For running cornices, skirtings, mouldings, angle beads, etc., it is particularly well adapted, and is very good and strong, the labor in working all these being similar, but somewhat less, than in other cements.

The cement was also experimented upon for external work. A piece of outside wall was selected in a most exposed position, and rendered with two parts of sand to one of cement finished with two of cement to one of sand, the sand being worked up to form a rough surface. This was done in January last, and has had all kinds of weather upon it since. After five months there is no sign of any deterioration whatever; indeed, its exposure has hardened it, proving that it might be used for outside work, especially in timber framing. As an additional proof of the strength of this cement, compared with other cements, an inch square briquette, seven days old, bore a strain equal to 370 lb. before breaking, and as 350 lb. is considered a very good and sufficient test for a Portland cement briquette of the same size and age, this is highly satisfactory. Its tensile strength being so considerable makes it very valuable for setting decorative tiles, glazed bricks, or "gauged" brickwork, where putty is now used; and there is no fear of its salting or expanding. It has already been used with the most perfect results in one of the large public buildings in London, and is considered so satisfactory that the architects are about to use it on a much larger scale elsewhere. To them the manufacturers are kindly permitted to refer privately any gentleman or firm who may be desirous of giving this new cement a trial. It has been carefully tested for painting in several ways by a well known London decorator, and with entirely satisfactory results, showing that it can be applied and painted upon at once, as with Keene's or Parian, or it may be left to get dry, and then painted, as within three weeks of being rendered it is thoroughly dry and ready for decoration, and will stand fine colors perfectly. With other cements, if left, the period that must elapse before they can be painted must be measured by months instead of weeks. In using it, no notice need be taken of "time of year or state of the weather." The plasterers can be put into a room with the requisite quantity of sand and cement, and work it straight away; there is no delay required for drying, for as fast as one coat is done, the finishing coat can be run and the whole completed. The treatment of the various cements at present in use varies very slightly; they are generally laid on in one thickness of from half to three-quarters of an inch, and of the proportion of one of cement to one or one and a half of sand, the surface being finished with a thin coating of neat cement.

The groundwork is often done in Portland, finished with Parian or Keene's; this, however, is rather doubtful policy, for besides bringing an additional material on to the works, it often (unless the Portland cement is most thoroughly dry, which of course takes time) sets up a chemical action detrimental to the finished face. Portland need never be resorted to with "Robinson's," which is sufficiently strong to carry easily four parts of sand and one of cement, making excellent work with that large quantity of sand, and being very economical in use on that account. Like some other cements, it can be brought up to a beautiful polished surface if required. Hitherto cements of this description have been used for plastering in first-class work only, their cost being against their general adoption, and we have had to be content with the ordinary style of plastering for large surfaces. However, we now hope to arrive at a better state of things, rendered possible by the introduction of "Robinson's cement," which, while comparing in every way equally with any of the others, can be manufactured and procured at so much less cost, bringing it within the reach of all, for general as well as special purposes. Plasterers who have used it report very favorably upon it, and that it works easily, very smoothly, and well; it does not discolor their tools, nor has it any other objectionable qualities. As its simplicity and cleanliness in working cannot be too strongly insisted upon, and its strength and durability are proved beyond a doubt, we are convinced that it only requires to be tried to establish its own claim to the consideration of architects, builders, plasterers, and their clients. It is needless here to specify all its uses. For private dwellings, public buildings, hospitals, schools, workhouses, and infirmaries it is especially well adapted, as its antiseptic qualities are a great advantage, and make it practically impervious to absorption and infection. It possesses the additional advantage of being as easily and thoroughly washed as an ordinary slab of marble. It has been already brought under the notice of several architects, who have expressed their entire satisfaction with it, and are adopting it because of its high quality, economy in use, and the satisfactory results obtained.—*Building News.*

THE BEST TEN BUILDINGS IN THE UNITED STATES.

As anything like an authoritative expression of opinion, the votes cast for the "best ten buildings" in the United States cannot be held to have as much weight as we would like, and so far as this goes we are disappointed with the result; but as we have been furnished with the names of 175 buildings which at least one architect thinks deserving of such rank, the purpose we had in view has been admirably subserved, as we have already stated.

The results of the ballot are as follows:

Total number of voters, 75.
" " " buildings mentioned, 175.
" " " " receiving more than one vote, 56.

The great proportion of "scattering" votes shows that an adequate judgment could be deduced only from a very much larger number of votes than were cast; but when it is remembered that only 56 buildings received more than one vote each, the balance is somewhat restored, and the final selection of the best ten from these 56 buildings may mean a good deal after all—especially in the cases of those which head the list.

The order in which they stand is:

I. Trinity Church, Boston, Messrs. Gambrel & Richardson, architects.
63 votes, or 84 per cent. of the votes cast.

II. United States Capitol, Washington, D. C. Messrs. Hallet, Hadfield, Hoban, Latrobe, Bulfinch, Walter, and Clark, architects.
41 votes, or 55 per cent. of the votes cast.

III. House of W. K. Vanderbilt, New York. Mr. R. M. Hunt, architect.
37 votes, or 49 per cent. of the votes cast.

IV. Trinity Church, New York. Mr. Richard Upjohn, architect.
34 votes, or 45 per cent. of the votes cast.

V. Jefferson Market Court House, New York. Mr. F. C. Withers, architect.
23 votes, or 30 per cent. of the votes cast.

VI. State Capitol, Hartford, Conn. Mr. R. M. Upjohn, architect.
23 votes, or 30 per cent. of the votes cast.

VII. City Hall, Albany, N. Y. Mr. H. H. Richardson, architect.
19 votes, or 25 per cent. of the votes cast.

VIII. Sever Hall, Cambridge, Mass. Mr. H. H. Richardson, architect.
17 votes, or 22 per cent. of the votes cast.

IX. State Capitol, Albany, N. Y. Messrs. [Fuller] Eidlitz and Richardson, architects.
16 votes, or 21 per cent. of the votes cast.

X. Town Hall, North Easton, Mass. Mr. H. H. Richardson, architect.
15 votes, or 20 per cent. of the votes cast.

Our readers can apply their own reasoning to this result, and draw their own conclusions in confirmation of or dissent from this classification without help from us. But as it would take so few votes to exclude from the list about half of those included in it, it seems only fair to give the names of those ten buildings which received the next greatest number of votes, and they are:

XI. New City Hall, Philadelphia, Pa. Mr. J. McArthur, Jr., architect. 14.
XII. Casino Theater, New York. Messrs. Kimball & Wisedell, architects. 14.
XIII. Lenox Library, New York. Mr. R. M. Hunt, architect. 13.
XIV. Produce Exchange, New York. Mr. G. B. Post, architect. 12.
XV. Columbia College, New York. Mr. C. C. Haight, architect. 12.
XVI. Broad Street R. R. Station, Philadelphia, Pa. Messrs. Wilson Bros. & Co., architects. 11.
XVII. Crane Memorial Library, Quincy, Mass. Mr. H. H. Richardson, architect. 11.
XVIII. Court House, Providence, R. I. Messrs Stone & Carpenter, architects. 10.
XIX. Central R. R. Station, Providence, R. I. Mr. T. A. Tefft, architect. 10.
XX. Harvard Memorial Hall, Cambridge, Mass. Messrs. Ware & Van Brunt, architects. 8.

The manner in which local pride or prejudice did or did not aid in bringing about the above result can be perceived by analyzing the votes cast by architects practicing in Boston, Chicago, New York, and Philadelphia.

Boston voters, 9 in number, cast 22 votes out of a possible 90 in favor of Boston buildings, as follows:

For: Trinity Church. Gambrel & Richardson, architects. 8.
Ames Building, Bedford St. H. H. Richardson, architect. 3.
Art Club Building. W. R. Emerson, architect. 2.
New Store for R. H. White & Co. Peabody & Stearns, architects. 1.
Spiritual Temple. Hartwell & Richardson, architects. 1.
First Presbyterian Church. R. M. Upjohn, architect. 1.
State House. Charles Bulfinch, architect. 1.
Boston and Providence R. R. Station. Peabody & Stearns, architects. 1.
Tower of Brattle Street Church. Gambrel & Richardson, arehitects. 1.
Mutual Life Insurance Co. of New York's Building. Peabody & Stearns, architects. 1.

Hotel Boylston. Cummings & Sears, architects. 1.
House for J. C. Phillips. Peabody & Stearns, architects. 1.

Chicago voters, 4 in number, cast 8 votes out of a possible 40 in favor of Chicago buildings, as follows:

For: The Pullman Building. S. S. Beman, architect. 2.
Philadelphia R. R. Station. L. Eidlitz, architect. 2.
C. B. & Q. R. R. Offices. S. S. Beman, architect. 1.
Cook County Court House. J. J. Egan, architect. 1.
Board of Trade Building. W. W. Boyington, architect. 1.
Mr. S. Kent's House. Burnham & Root, architects 1.

New York voters, 12 in number, cast 70 votes out of a possible 120 in favor of New York buildings, as follows:

For: House of W. K. Vanderbilt. R. M. Hunt, architect. 9.
Columbia College. C. C. Haight, architect. 8.
Jefferson Market Court House. F. C. Withers, architect. 7.
Trinity Church. Richard Upjohn, architect. 6.
Casino Theater. Kimball & Wisedell, architects. 5.
House of Louis C. Tiffany. McKim, Mead & White, architects. 4.
House of Henry Villard. McKim, Mead & White, architects. 3.
Lenox Library. R. M. Hunt, architect. 2.
N. Y. Mutual Life Ins. Co.'s Building. C. W. Clinton, architect. 2.
Produce Exchange. G. B. Post, architect. 2.
House of Cornelius Vanderbilt. G. B. Post, architect. 2.
Union Theological Seminary. Potter & Lord, architects. 2.
St. Patrick's (R. C.) Cathedral. Renwick & Sands, architects. 2.
Madison Avenue M. E. Church. R. H. Robertson, architect. 2.
Dakota Flats. H. J. Hardenbergh, architect. 2.
Metropolitan Opera House. J. C. Cady & Co., architects. 2.
House of W. H. Vanderbilt. Atwood & Snook [Herter Brothers], architects. 1.
Jewish Synagogue. L. Eidlitz, architect. 1.
St. Paul's. 1.
Dutch Reformed Church. Wheeler Smith, architect. 1.
Manhattan and Merchants' Bank. Wheeler Smith, architect. 1.
Presbyterian Hospital. R. M. Hunt, architect, 1.
City Hall. 1.
Union League Club House. Peabody & Stearns, architects. 1.

Philadelphia voters, 6 in number, cast 21 votes out of a possible 60 in favor of Philadelphia buildings, as follows:

For: Masonic Temple. J. H. Windrim, architect. 4.
Penn. R. R. Broad Street Station. Wilson Bros. & Co., architects. 4.
New City Hall. J. McArthur, Jr., architect. 3.
Girard College. T. U. Walter, architect. 3.
Insurance Co. of North America's building. Cabot & Chandler, architects. 2.
Merchants' Exchange. —— Strickland, architect. 1.
St. Mark's Church. John Notman, architect. 1.
Philadelphia Trust Co.'s Building. J. H. Windrim, architect. 1.
Academy of Music. G. Runge, architect. 1.
Post Office. U. S. Supervising Architect's Office. 1.
New Jerusalem Church. T. P. Chandler, Jr., architect. 1.

The votes for the two Providence, R. I., buildings were cast entirely by local architects.

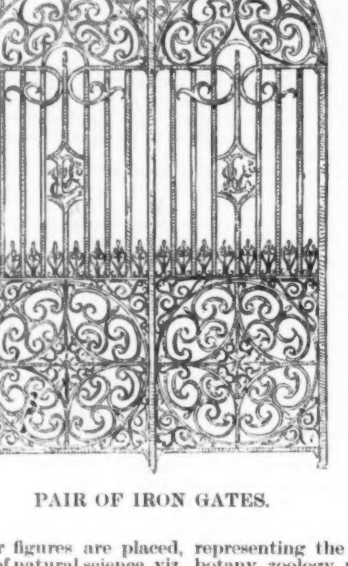
In conclusion, we can only say that architects of all varieties of predilections and attainments, practicing in every part of the country, have contributed to this result, and that we find considerable internal evidence that their opinions were expressed with care and deliberation.—*American Architect.*

THE LINNE MONUMENT AT STOCKHOLM.

A statue of Sweden's greatest son, Linné, the originator of the present system of botany, was erected in the handsomest square of the city of Stockholm, the Humlegards Park, in front of the Royal Library. Linne's high standing in the natural sciences was acknowledged by all civilized nations during his life. In the middle ages the natural sciences were not far advanced, and it required great discoveries to develop them. In the sixteenth and seventeenth centuries the results of the studies of wise men began to show their influence, but the defects of the systems became more and more apparent, and it was evident that great reforms were necessary.

This great reformer and originator, Carolus Linnæus, was born in the Smaland Forest, May 13, 1707. He made botany his special study. Before him other scientists had described the different forms of plants, etc., as well as they could, but without any system of classification, and the material collected was of very little value. It became very evident that a new system would have to be created, by which the work could be classified in a simple and comprehensive manner. Linnæus, who was a student at the University of Upsala, published his new system of the classification of plants, known as the sexual system, in 1737. This system rapidly replaced all others on account of its simplicity and clearness, and Linne was, and still is, accepted as the lawmaker of botany. He did not devote all his time to botany, but also studied the natural sciences in general. At the age of twenty-eight he published his first edition of his Systema Naturæ. He also published works on zoology, but his greatest fame was achieved by his botanical studies.

The statue of Linne, which was modeled by Prof. Frithiof Kjellberg, was cast in Sweden. It represents the great naturalist at the age of about twenty years. Under his left arm he holds the numerous folds of his cloak, and in his left hand a volume of the Systema Naturæ and a small bouquet of flowers (Linnea orealis). The statue, about 13 ft. high, is placed upon an octagonal base of polished granite, with four projections, on which four figures are placed, representing the four branches of natural science, viz., botany, zoology, medicine, and mineralogy.—*Illustrirte Zeitung*



PAIR OF IRON GATES.

PAIR OF IRON GATES.

The gates shown were made by the St. Pancras Ironwork Company for a bank at Shanghai, and were entirely of hand-forged iron except the scroll work, which was of malleable iron. The gates were 9 ft. wide and 14 ft. 6 in. high, and the construction throughout was very strong and massive.—*Building News.*

GINGER ALE.

A practical correspondent of the *Mineral Water Trade Review* describes his process for making ginger ale, and states that his product seems to give general satisfaction: The first point is to select a good, sound, unbleached ginger; Jamaica may be preferred, although I found a fair example of Cochin yield a very good extract. The great aim is, as far as possible, to insure the freshness of the root, as ginger loses a considerable amount of its peculiar odor, although its pungency remains almost unchanged by long keeping. The extract is prepared by pounding 20 oz. of the root into a coarse powder, which should be rendered uniform by passing it through a sieve of forty meshes to the inch; the granules thus obtained are mixed with a sufficient quantity of dilute spirit, composed of equal parts of alcohol at 60° and distilled water, so as to form a paste, which is placed in a percolating apparatus, and left to macerate for forty-eight hours. Next pour on dilute spirit, so as to obtain 70 oz. of tincture; press out the marc strongly, and finally add sufficient liquid to make up 80 oz.

Of the tincture thus prepared, take 7 oz., mix with 6 pints of water and sufficient kaolin (China clay), or thoroughly washed whiting may be used; filter through paper so as to obtain a perfectly bright filtrate, in which dissolve 6 lb. of sugar without heat. This quantity will be found easily soluble in the above proportion of water.

This forms the first part of the process, which is completed by the addition of 140 drops of tincture of capsicum berries (obtained by macerating 8 oz. of the bruised berries with 25 oz. alcohol at 60° and 25 oz. distilled water, and proceed as in making the essence of ginger; the product should measure 50 oz.); also 180 drops tincture of vanilla (made by macerating 1 oz. vanilla pods, thoroughly bruised in a mortar, with 2 oz. distilled water and 8 oz. alcohol at 60° for eight days); also 6 drops essence of cloves (essential oil of cloves 1 part, alcohol at 60°, 9 parts) with 30 drops essence of lemon, which quantity will be found perfectly soluble in the syrup, provided that the quality is good; and 2 oz. of citric acid dissolved in 6 oz. of water.

The sirup thus completed may be colored by the addition of burnt sugar as required, and finally filtered with a little paper pulp in the usual way. One ounce and a half is the requisite quantity for each bottle. If it is deemed necessary to give an extra amount of foam more than exists naturally in the ginger, a most efficient heading may be obtained from the following formula: Soapwort root (*Saponaria officinalis*) in coarse powder, 4 oz.; animal charcoal, 2 oz. Macerate two days in a mixture of alcohol 60°, 4 oz.; pure glycerine, 4 oz.; distilled water, 8 oz.; then percolate so as to obtain 16 oz. of finished extract. Two drachms of this will be found sufficient for 1 gallon of syrup.—*Chemist and Druggist.*

THE NEW MONUMENT TO LINNE, AT STOCKHOLM.

A CHINESE CHAIR.

THIS chair is in common use at Foochow, and only costs about 2s. Each pair of legs at the side, together with the side bars of the seat, are in one piece. This is effected by cutting two semi-elliptical notches in a straight piece of bamboo, so that it can be bent round to form three sides of a square. The front and back bars of the seat are placed in the notches, and thus grasped firmly by the side bars and legs when bent, the semi-elliptical notches being transformed into circular holes by the operation of bending. The back and seat are made of strips of bamboo, bent outward so as to form a springy surface, and strengthened behind by a couple pieces of cane split up the middle. The whole chair is of the same material, and is carefully pinned together.

THE GUMERACHA GOLD FIELDS.

THE title seems a misnomer, as the gold fields are in point of fact some seven and a half miles distant from the township of Gumeracha. The road, after leaving the latter place, runs through the pretty little township of Forreston, and after taking us some two or three miles further through some finely-timbered and characteristic Australian scenery, brings us suddenly upon the scene of our destination. We dash on between the long and straggling lines of rude tents and smithies, and fetch up in front of a primitive structure labeled "Perry's Store," where the coach disgorges its mails, its passengers, and luggage in the midst of a throng of eager and anxious miners. Taking our portmanteau in one hand, and our sketching materials in the other, we wend our way up the gully, and are astonished at the [evidences of mining activity which greet us on all sides. There are two improvised stores, the principal one (that of Mr. Blue, a resident of Gumeracha) being situated at the head of the gully, and doing an apparently thriving business with the two or three hundred miners who have taken up their abode in this and the adjoining gully. Occasionally a provision van also finds its way into the camp. The necessaries of life are to be had at rates very little in advance of Adelaide prices. Owing to the long-continued drought and the absence of running streams of water available for sluicing purposes, mining operations have been confined (with a few exceptional cases) to exhuming the gold-bearing soil, and there are immense heaps of wash-dirt thrown up along the course of the gully, and only awaiting the advent of rain to prove their richness or otherwise in the precious metal. Good nuggets have been found in some of the claims, notably in Fisher's, which is shown in the foreground of our sketch, close to Mr. Blue's store. About £130 worth of metal was taken from this claim in six weeks, culminating in a 20 oz. nugget, which was exhumed on Good Friday last. There are mysterious whispers that one or two have discovered the reef, and that it will before long be worked, but be this as it may, the rain is now earnestly desired to satisfactorily show the alluvial character of the country. This is the original "Dead Horse Gully," now known by the more euphonious title of "Watts' Gully." But wherever the miner prospects, whether there or in the adjacent gullies, he does not fail to obtain "the color." It is still a moot question whether the gold is in payable quantities, but the indications in favor of the affirmative are quite as strong as in the case of the longer known Echunga fields, and, in common with the public generally, we await with some degree of anxiety the further development of those diggings.—*Pictorial Australian.*

[Continued from SUPPLEMENT, No. 503, page 8037.]

THE SUN'S WORK.

A NEW THEORY OF RADIANT HEAT.

By F. JARVIS PATTEN, U. S. A.

To establish this corollary has been the unchanging tendency of exact science in our century. It asserts the unity of all force, and tells us there is but

ONE FORCE IN NATURE.

The unshaken testimony of all investigation points to this one result; for, turn where we may, science everywhere insists with increasing emphasis that all kinds of force are but forms or manifestations of one central force issuing from one fountain head of power.

A CHINESE CHAIR.

This view has resulted in broad generalizations which have added greatly to our conceptions of the various operations of force upon the different forms of matter by which we are surrounded, and of the endless fluctuations and changes of which we are ourselves the indirect results.

Now, in speaking of nature's forces, though we refer to them as heat, light, electricity, magnetism., etc, we almost unconsciously think of the one force of nature as thus variously exhibited or made manifest to our senses, and it is now generally assumed that they are all but the different results of the various conditions under which the one force is constrained to seek its interpretation.

Illustrations of this are on every hand, and nothing is easier to show than the widely different results produced by any one form of force, depending only upon the conditions of its application. An instance from Prof. Gray will serve our purpose:

"If I apply a red-hot iron to my finger, I blister the flesh and cause bodily pain; but if I apply the same heated iron to a thermo-electric pile, I produce no physical or mechanical injury to it, but I set up a current of electricity which will give mechanical motion to the armature of a magnetic instrument placed in its circuit. Again, if I apply the same red-hot iron to a loaded cannon, the powder it contains ignites, and the ball is sent whizzing through the air.

"Now, all these effects were the result of applying the same identical force in the form of heat to different materials. . . .

"A waterfall," he says, "is the *result of what is called the force of gravity.* The water, by the power of the sun's rays, is placed in a position where it can do work, and the result is a *mass in motion, or moving energy.*" If we place a waterwheel in proper relation to the fall, the wheel will turn and do work, and by its movement we can put in operation a dynamo machine whose current may in turn be carried to an electric lamp, where the original force assumes the form of heat and light. All these exhibitions of energy come from the same source—the waterfall; and it seems impossible to study the various changes that may be derived from mechanical energy in any form without reaching the conclusion that all force, whatever its manifestation, is the offspring of a common parent—a single force.

But the question arises: What is the one force? In the illustrations of force transformation, we have in each train of cause and effect found the gravitative attraction of masses, or gravity, an indispensable factor.

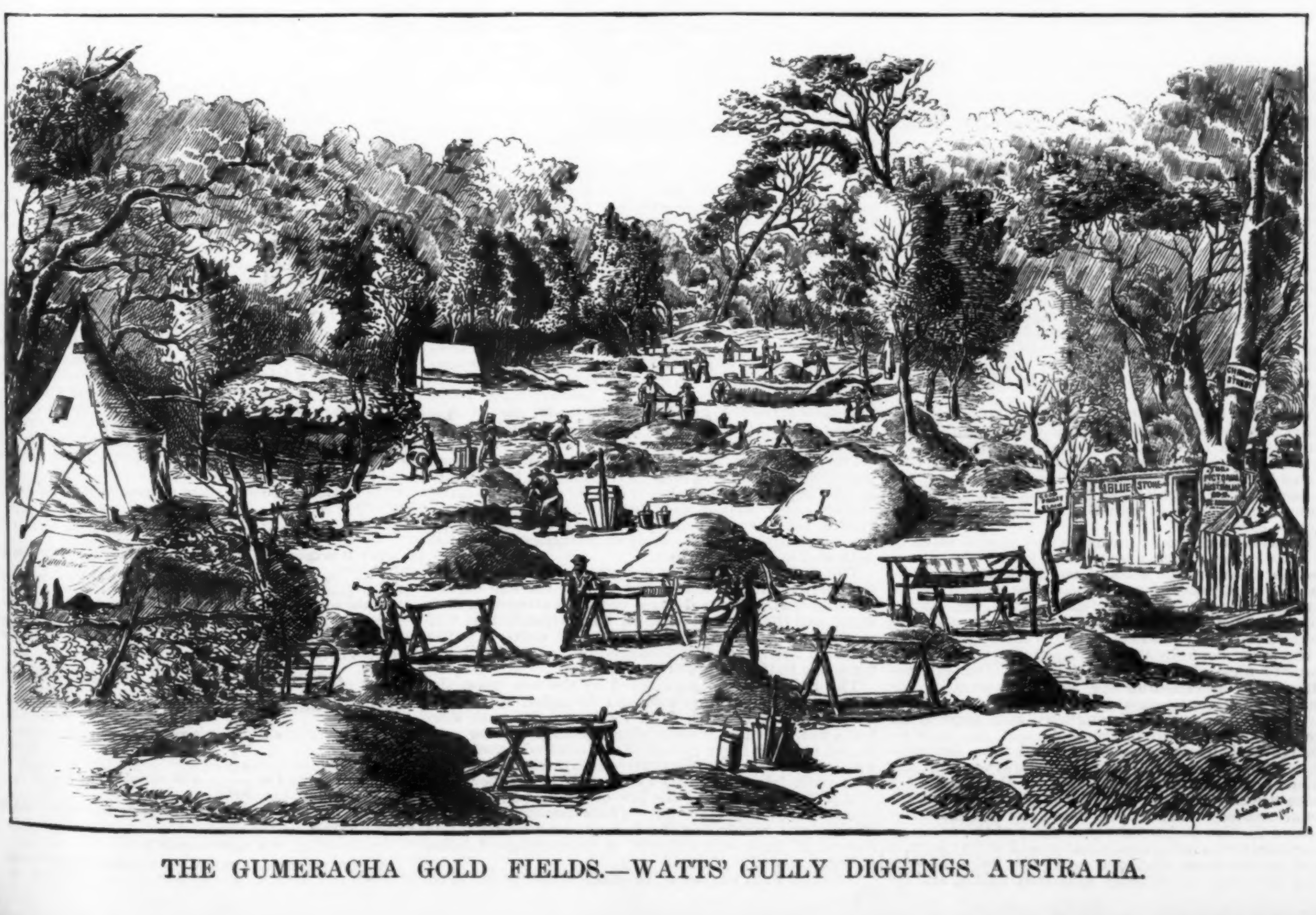
In the last example it was the starting point to get mass motion. In this instance it was necessary that the water should be raised to a higher potential level, from which moving energy could be derived with all its possible transformations, all of which have necessarily a certain ratio to the first step—a definite relation to the amount of gravity overcome.

In the first illustration no mention was made of gravity overcome, no weight lifted, no similar form of acquired potential, and, inasmuch as gravity does not appear, the illustration is particularly valuable, being typical of a large class.

In it we started with the heated iron, but we did not consider how this particular form of heat force became so identified with the iron that it could be used in the various ways described. This force, or energy, in the form of heat, must evidently have been transferred to the iron from some pre-existing form of stored potential, probably, we will say, a piece of coal or wood. Going a step farther, and inquiring how this silent energy became locked up in the particles of coal, we know it was the work of the sun's rays, performed by opposing a resistance to the force of gravitative attraction; and could we view the details of all these varied steps, it would also be apparent that the stored energy in the coal bore a certain definite relation to the measure of gravity overcome, and the resulting transformations have been quite as exact as had we started by lifting a weight of water to a certain height, whose stored energy could be accurately expressed in foot pounds. We are thus brought, no matter how varied the transformations of force, to the same initial point, where the first question has always to be answered:

How much gravity, how much of the constant, universal attraction of one mass of matter for another, has been overcome? What has been the measure of resistance this ever ready, ever present force of attraction has opposed to work? For it seems all subsequent values must bear a definite ratio to this gravity resistance, in which all other forms appear to have a beginning.

Would it not seem, then, that this only constant, unchanging attraction of matter called gravity, and from



THE GUMERACHA GOLD FIELDS.—WATTS' GULLY DIGGINGS, AUSTRALIA.

which any desired form of force may be so readily derived, has the strongest claims to be regarded as the "one force" of nature? Endowed as it is with characteristics that render it pre-eminent, it is absolutely universal in its nature, affecting alike the nearest and remotest parts of the universe; it is inherent in matter itself, and inseparable from it.

That bodies attract each other as their masses directly, and the squares of the distances that separate them inversely, is an axiom of science, and as such is pregnant with meaning, for it describes in accurate and unmistakable terms the action of a constant, unceasing force, independent of all conditions and from which all other forms of force find an easy derivation.

Let us assume, then, as a principle, that the transformation of the "one force," gravitative attraction, into the energy of moving masses accounts for all the physical forces of nature, whatever their form of manifestation, and we have at once a key to the problem of

THE SUN'S WORK,

and an explanation of the source and nature of his radiant heat.

We have gazed into the depths of space, where our earth appears a mote in the sunbeam; we have considered the various theories which represent the sun filling that void with heat and light; for the little ray that may fall upon that speck and its isolated companions, and the profusion of waste that is incident to them, all assert the want of a new hypothesis.

We have also considered the various manifestations of force as they are going on about us, and in their unceasing fluctuations we recognize the action of a single law to which their many changes are subservient. All the varied forms of force that mingle in the sunshine of a single day we have traced to a common origin, that origin, the universal force of gravitative attraction, from which all others are so readily derived, is also the force that binds our planetary system to the sun.

No transformation has ever taken place, however delicate or however subtle, that did not contain somewhere in the chain of cause and effect that particular change due to the gravitative attraction of masses; in this way every demonstration of energy appears to have had its origin, whether heat, magnetism, or electricity; whenever in action, the force seems to have originated in such a change.

If, then, the principle of conservation of energy has indeed a broad and general application, the various manifestations of vibratory energy by which we are surrounded in the heat and light of a day must also have had their origin in some such transformation of the "gravity pull" of masses, and in a manner quite similar to that found to exist in all the various fluctuations of terrestrial force that have come under our observation.

The conservation of energy points unmistakably to one force in nature, but our accepted science and theories of the sun tacitly admit two great and very important exceptions to the general law, and there are two great questions that our existing views have left unanswered:

The *first* is: What becomes of the vast stream of energy the sun seems ever radiating into space? Energy that the science of to-day presumes lost. And the *second* question, equally important, is: Where, and in what form, appears the mechanical energy of the gravity pull that the sun's mass is constantly exerting upon the earth? Where is the energy of that constant work, what becomes of it?

If we assign to the conservation of energy the universal scope it undoubtedly has, the two questions may be answered with a single enunciation:

"ONE IS THE TRANSFORMED ENERGY OF THE OTHER."

Our hypothesis presumes the sun's radiant heat to be the transformed energy of the "gravity pull" his mass is constantly exerting upon the earth, a force that is constantly at work, overcoming a resistance doing work; and we cannot presume the energy of that work to be lost, for everywhere in the vast domain of nature that mechanical energy is expended we expect to find a corresponding manifestation of energy appearing in some other form.

By an extended application of those principles which explain so well the endless fluctuations of terrestrial forces, we may reasonably hope that the work of the sun system may be made clearer to our conceptions; for if our system is constituted as the conservation of energy would lead us to suppose, we may expect to find that all the different manifestations of physical force will appear as the transformed values of the moving energy of the system—the "one force" under different forms, the gravity force, the energy of whose accomplished work we know cannot be annihilated, but must appear in some other form—heat, light, electricity, etc.

To show how this is a fair assumption, a guess supported in a measure by facts, if not actually proved by them, we have to compare *the work performed by the gravitative attraction of the sun with the work performed by the constant stream of radiant energy that the sun appears to send us in the form of heat.* If the assumed hypothesis is true, the two values should be equal to each other.

We have, therefore, to measure the entire value of the sun's radiant force, expressed in units of work; we must also measure the work of the sun's attraction, or "gravity pull," exerted in the same time, and expressed in terms of commensurable units with the former amount. Their equality should be strong presumptive evidence that the sun's heat is the transformed energy of the work done by the gravity pull. Owing to incomplete methods of observation, and the extreme difficulty of ascertaining the exact measure of the energy that seems brought to us in the sun's ray, we have necessarily to deal throughout with approximations, the most delicate instruments and the most reliable investigations not having placed these estimates beyond dispute. It is fortunate, however, for the value of this inquiry, considered in the light of a demonstration, that neither the exact measure of the "solar constant" on the one hand, nor the exact distance of the sun and weight or density of the earth on the other, are as indispensable as would at first seem, it being easy to show that some particular value of each lying between the extreme estimated values, and beyond which neither can pass, must give the desired results.

First, with reference to the sun's heat work: That quantity which measures the intensity of the sun's heat radiation *as it impinges on the earth* is called the "solar constant."

It is a constant increment of heat, and varies from Pouillet's estimate of 17·6 calories to that of Forbes, who places it at 28·2. Modern authorities seem agreed that 25 calories is a fair estimate, not far from the truth, and it will, therefore, be assumed as a basis of calculation.

This number 25 is the number of calories or heat units received per *minute* upon *one square meter* of surface exposed perpendicularly to the sun's rays at the upper limit of our atmosphere, and is the quantity of heat that will raise the temperature of 25 kilogrammes of water 1° Centigrade in one minute.

From this value it is easy to pass to the entire amount of work performed by the sun upon the whole surface of the earth in a given unit of time.

It is evident that the total amount of energy in the form of heat received by the earth in a given period of time is that which would fall on the exposed hemisphere of the earth perpendicular to the sun's rays, or, what is the same thing, on a meridian circle of the earth, whose area, in round numbers, is fifty millions of square miles, each square mile containing about twenty-eight million square feet.

By means of the mechanical equivalent of heat the amount of energy thus received upon the entire hemisphere exposed to the sun's rays for a given time can be expressed in units of mechanical work.

Expressed in English units, a calory is equivalent to raising the temperature of 10 lb. of water 1° Fahrenheit in one minute for every square foot of surface, or 10×772 (mechanical equivalent of heat) = 7,720 foot lb. per minute.

For convenience of calculation, assume the unit of time to be $\frac{125}{1000}$ of a second. Then the energy of the solar constant expressed in mechanical units of work accomplished during that time would be 15·36 foot lb. per square foot exposed for such a period, which gives for the entire amount of work during the same time on the hemisphere exposed to the sun, in round numbers, 11,250,000,000,000 foot tons of work, or about 11,000,000,000,000 foot tons.

Having thus obtained an expression for the work of the solar constant, let us proceed to inquire what is the work of the sun's gravity pull as exerted upon the earth during the same period of time.

The simplest principles of mechanics will serve our purpose. That science teaches that if a moving body be stopped, either suddenly or gradually, or if its motion be accelerated or retarded in any way, a quantity of heat will be generated exactly proportional to the work of resistance, and that the amount of energy arrested motion will develop is always proportional to the work of resistance, whether the motion be wholly or only partly arrested and overcome. If our assumed hypothesis be correct, and we can find the work resistance opposed to the gravitative attraction of the sun, its work expressed in mechanical units should be equal to the work of the sun's radiant force as determined for a like period.

To ascertain the resistance opposed by the motion of the earth to the sun's gravitative attraction, we proceed by the identical methods used to arrive at the same result in case of a moving body at the earth's surface, or in the earth's atmosphere, with the single exception that in the present instance the earth must be regarded as a moving mass *with respect to the sun*, and the sun-weight of the earth will be the measure of its mass, or the gravity pull as we have styled it.

In moving through space, the earth has a certain energy of motion which is, in a measure, constantly overcome, and we have only further to assume that arrested motion produces heat in proportion to the work of resistance. Illustrations of this are so common, and the principle is so generally recognized, that it requires no demonstration.

Let us, then, consider how it appears that the force of gravitative attraction, the sun pull exerted on the earth, does work; let us consider how this great force overcomes a resistance.

To complete its annual course about the sun, the earth is flying through space with a high velocity. It completes the journey in 365 days 6 hours and a fraction; and to do this it must move with an average speed of about 18 miles in every second of time. However inconceivable such velocity of motion appears, far more so is the *moving energy* developed by this flying mass. Without attempting to picture its value, we are concerned with a fact far more significant to us—that this energy of motion, great as it may seem, is in a measure arrested and overcome during every second of the earth's yearly path. To realize this we have only to consider that, were it not for the gravity pull exerted upon the earth by the sun, the earth would move in a straight line along a tangent to its curvilinear path. The sun's attraction during each successive unit of time checks the motion imparted by the tangential impulse and holds the earth to its orbit.

The earth literally falls to the sun, the distance from which it falls being as constantly renewed by the tangential impulse which takes it over 18 miles of distance during every second, and during which time it gravitates, falls, or is pulled by the sun's attraction ($\frac{1}{100}$) one hundredth of a foot out of its rectilinear tangential path and nearer to the sun.

The tangential impulse is thus constantly opposing a mighty resistance to the gravity pull the sun exerts. In overcoming this resistance the sun's attraction does work, and the amount of work thus expended in 0·12 second may be expressed in mechanical units; it is the work of inertia, and is measured by half of the living force due to the energy of mass motion.

The gravity attraction exerted by the sun upon the earth, and which is just sufficient to deflect it the fraction of a hair's breadth from its tangential path during a unit of time, is something enormous, being estimated at (3,600) three thousand six hundred quadrillion tons, or 3,600,000,000,000,000,000 tons expressed in figures. The earth falls constantly to the sun in obedience to this pull, and following the law of falling bodies under the action of a constant force it falls through a distance of ($\frac{1}{100}$) one hundredth of a foot approximately in one second of time, and while it is journeying 18 miles through space.

Starting from any assumed point, it moves in 0·12 of a second over something more than two miles, and during the same time it will have been pulled toward the sun through a distance of something more than the one ten-thousandth of a foot, in figures 0·000156 ft.; and at the end of its fall through that distance it has a velocity of 0·0025 ft., twenty-five ten thousandths of a foot, and the work due to this fall is measured by $M \frac{v^2}{2}$, in which M represents the weight of the earth, its mass with respect to the sun, or the gravity pull the sun exerts upon the earth, and v is the velocity at the end of a given time, t, estimated in the direction of the sun—making v the velocity at the end of the time, $t = 0·125$ sec., twelve hundredths of a second, and substituting for M its value estimated at 3,600 quadrillions of tons, we have

10,800,000,000,000 foot tons,

about eleven trillion foot tons for the work of the sun's attraction in twelve hundredths of a second, which we have seen was also the measure of the work performed by the sun's radiant heat on the exposed hemisphere of the globe during the same time.* They are identical in value. In planetary motion, then, as we have seen, there is a constant force of great magnitude ever at work, and opposing during each consecutive unit of time a definite resistance to the gravity force.

The earth is flying through space at a high velocity; the centrifugal force continually removes the mass to a point from which it may as continually fall to the sun, to a point from which the moving energy of mechanical motion may be developed by the incessant action of gravity.

The earth is thus in a position of constantly renewed potential, of constantly arrested fall. Its energy of motion, in obedience to the gravity attraction, does work whose measure by comparison we have seen is equal to the work of the estimated amount of heat energy we receive from the sun during a corresponding period of time.

The hypothesis we would present assumes that the radiant force thus received from the sun in the form of heat is the transformed energy of his gravitative attraction.

By this assumption the mass of the sun during every second of time is exerting upon the earth a definite amount of mechanical energy which is transformed, like every other mechanical force, at its point of application—the earth—to the various forms of the sun's radiant force, of which we are momentarily conscious.

In the work of the gravity force we see great energy constantly exerted, and we may well inquire what becomes of this energy: It acts upon the earth as any mechanical force acts upon matter, constantly accelerating or retarding motion, overcoming a resistance, and we know the force so expended can be neither lost nor annihilated, it can only change its form to heat or some other manifestation of vibratory energy. It would certainly not be logical were it even possible to make an exception of this vast working power of our system, the gravitative attraction of the sun. It arrests visible mechanical motion, and where is the transformed energy of the work? What are its dissipated forms, and how do they appear?

If the conservation of energy is a true doctrine, it cannot be supposed for a moment that this great force holds the planets in their position about the sun, and ends there; for that principle tells us no item of force can be created or lost, it can only change its form. We should, therefore, naturally expect to find the energy of the earth's mass motion, as in the case of all other moving energy, transformed at its point of application, where the work is done, to the varied forms of energy in which it is dissipated throughout the matter on which it acts; the kind of energy manifested—heat, electricity, etc.—it assumes, depending upon the conditions and media of transformation.

In most instances of mass motion, a far greater part of the moving energy is transformed to heat, though a part may assume other forms, and it should be in general the same with the energy due to the sun's attraction. This force also on performing work should appear in the matter upon which it acts, transformed to heat and other manifestations of vibratory energy.

The work due to arrested motion in an assumed unit of time has been measured roughly, and we should look for its appearance in some other form; and the work of the sun's heat, as we understand it, at the surface of the earth seems to be its exact counterpart in value.

It is evident that, in these comparisons, accuracy of estimated values is of secondary importance, many of the data assumed being subject to wide ranges of possible error; but as any possible value of each of them must also give results corresponding closely with those deduced, the demonstration, owing to the possible error of assumed values, loses little of its importance.

From what has been assumed and deduced, it would seem at least a fair conclusion that the work of gravity is just sufficient to account by its transformation for other forms of force which appear as the sun's direct action upon the earth, and which we have heretofore attributed to a constant outpouring of radiant heat in all directions, requiring for its conveyance an elastic

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* The analytical expression of the assumed conditions of our hypothesis would be:

$$\frac{M v^2}{2} = C t. \text{ (Eq. 1.)}$$

In which M is the weight of the earth of the sun's attraction expressed in foot tons.

C is the value of the solar constant for the entire earth expressed in the same units.

V is the velocity of fall acquired under the action of M in the time t.

Equation 1 is one of condition, containing two indeterminate quantities, v and t, but from the laws of falling bodies under the action of a constant force we have

$$v = g t. \text{ (Eq. 2.)}$$

In which, of course, g must represent twice the space passed over by the earth in the direction of the sun in the first second of fall.

Substituting and solving with respect to v and t, we get

$$v = \frac{2 C}{M g} = 0·0025 \text{ ft.}$$

$$t = \frac{2 C}{M g^2} = 0·125 \text{ second.}$$

And again, from laws of falling bodies, for the distance or height fallen through, we have

$$h = \tfrac{1}{2} g t^2 = 0·000156 \text{ ft.}$$

M = 3,600,000,000,000,000,000 tons. C = 90,000,000,000,000 ft. tons.
g = 0·02 foot.

medium in space—a clumsy hypothesis, that also admits of an equally great dissipation of the sun's heat in all directions, and countenances an absolute annihilation of force, which, in nature, must be as impossible as the loss of an atom of matter.

If, however, we regard all terrestrial heat as the transformed work of gravity, we have an adequate origin of all mechanical force in the assumed "one force" of matter requiring no medium for its transmission, yet everywhere active, depending for its intensity alone upon the distance over which it acts, being absolutely nothing only when the distance through which it is exercised is infinitely great.

Viewed in the light of this hypothesis, the sun exerts only a gravity force upon the mass of the earth, where it is transformed immediately to other manifestations of energy, all subservient to a definite purpose, the maintenance of planet life.

As a mere digression at this point, this same view of our material system suggests at once a purpose in that infinite separation of sun systems apparent in the cosmical distribution of matter, their remote distances apart, approaching so closely to infinity that their mutual interference creates no disturbance of force values, each containing for itself a constant, immutable sum of energy.

An interesting calculation, not as useless as might appear, when considered in the light of the views here presented, shows this principle very clearly. The nearest fixed star, supposably the center of a sun-system like our own, is 20 trillions of miles distant from our own sun. At half this distance, or 10 trillions of miles, our sun exerts an attractive force so slight that it would require more than a thousand years to move a mass at that distance through a single inch of space.

To all who accept the conservation of energy and the correlation of forces as general principles of our material system, the question must present itself as to what becomes of the moving energy of our planet, unless, as here suggested, it is transformed to other values, forms of force which we have been accustomed to regard as being in some way a direct emanation from the sun, as the heat of a stove is transmitted to the media that surround it on all sides.

If, on the contrary, these energies are but the changed manifestations of the gravity attraction, we are then part of a perfect, independent system of force and matter, dynamically conservative in this respect. Thus, wherever matter exists in space, there is the gravity force in operation, whose transformed energy may produce any form of force.

In space outside there is no force, as there is no matter upon which the gravity force can be exerted. In this view of the planetary structure, space becomes a vacuum, dark and cold, simply space and nothing more.

In this view our sun and all other suns are vast accumulations of matter, whose mass alone is the measure of their force-producing action, matter being everywhere the measure of force.

The sun's mass thus becomes the exponent of his power; in the system it is the measure of what he can do for the planets dependent upon him, as all the energy required for the maintenance of planet life is but the transformed energy of the sun's attraction for each of them.

It is also apparent that in this view of the system the sun's force *is all* converted to use, and in that field of operation only where it can serve a definite purpose. In this light the solar system may be regarded simply as a machine, perfect in the mutual interaction of all its parts; the essential forces, sun light, sun heat; the radiant energy of the system is in each planet a measure of the sun's attraction for that body, converted at the surface of each to heat and light, the relative quantities thus transformed depending upon the varied conditions under which the transformation takes place, may be such as to give the nearer planet, Mercury, and the outer planet, Neptune, just such quantities of heat and light as will admit of the existence in other planets of life not far different from our own.

In the light of an hypothesis so plausible, so in keeping with the whole tendency of scientific thought, may we not safely abandon our old ideas of the wasted energy of the sun, which only admits the use of the one two-hundred-millionth part of all his force for the maintenance of life, the rest being lost to our system in the depths of space, when, by the acceptance of this simple and beautiful transformation of force, all manifestations of energy, however great or small, become a part of the one great self-sustaining force of a single independent material system, perfectly conservative in the mutual interaction of its parts?

[The Garden.]

GOOD WEEPING TREES.

Among weeping trees are some of the most charming examples of ornamental trees. Graceful in outline and growth, they possess all those characteristics which render them especially valuable for the embellishment of landscape, park, or lawn. This peculiarity of form among weeping trees is a precious one, inasmuch as the contrast between the rigid upper portion of the tree and the pendulous outer and lower parts forms a very striking and attractive feature, quite distinct from the aspects usually presented by other trees. But for all this they require to be employed discreetly, or the good effect which they are capable of producing is destroyed. They should be planted sparingly and not near one another, and carefully selected and suitable sites must be chosen for them, or half their charms will be lost; when met at every turn or too often repeated, their interest and attraction are greatly diminished. They should never form large groups or masses, nor be mixed up with other trees in belts or borders. In the hands of a skillful planter they are capable of producing the most charming results, and are more effective in giving character and expression to a landscape than any other trees.

Some of the weeping trees, however, with which we are familiar are truly formal and avowedly artificial, and should be sparingly introduced—in some instances not at all, and nothing but a vitiated taste would sanction their use in well-kept places. The main fault with most of these trees is that the branches all droop from a given point, and only one; whereas in such trees as the old weeping willow the falling tresses of spray are broken and diversified, like waves in a mountain cascade. Their only position seems to be in association with architectural terraces, statuary, fountains, etc., for a tree with its branches all growing downward is just about as natural as jets of water thrown upward.

The following are some of the best trees of a weeping habit of growth that are now available for ornamental planting:

The Weeping Birch is admirably adapted for lawns. Owing to the slenderness of its branches, which in the original plant were so weak as to creep along the surface, great difficulty was experienced in propagating it. To the graceful elegance peculiar to the birch family it adds the odd, singular, erratic habit of the weeping beech. It has long, slender, thread-like branchlets, which fall from the main branches like spray. Grafted upon stems 6 feet to 7 feet high, it can be grown into a rounded, regular head, like the Kilmarnock willow, or left to itself it will send up a leading shoot with side branches like the cut-leaved, only more spreading. In this tree we have gracefulness and picturesqueness combined.

The White Weeping Birch (Betula alba pendula elegans) is another charming variety, which originated with the Messrs. Bonamy, at Toulouse, France. Its habit of growth is graceful. Grafted on stems 6 feet to 8 feet high, the branches grow directly downward, parallel with the stem. Its decidedly pendulous habit, rich, handsome, delicately foliaged branches, render it particularly showy and attractive on the lawn. Among ornamental trees of recent introduction this and Young's weeping may be considered the most valuable acquisitions of many years. In the old variety of weeping birch the branches fall with so perceptible a curve as to give a rounded appearance to the upper part of the tree; but in this new weeping birch each branch hangs down almost perpendicular, forming an acute angle with the trunk. This peculiarity gives to the tree a veritable weeping aspect, which is enhanced by the flexibility of its swaying limbs and the varied tints of its foliage.

grows strongly, weeps gracefully, and in spring is one of the most showy, free-flowering of willows.

The Weeping Beech is undoubtedly one of the most remarkable of drooping trees. Its habit of growth is somewhat odd, but at the same time picturesque and beautiful. In a young state it is perhaps less attractive than other weeping trees, and it is often grafted on a short stem, on which its true pendent habit is not seen to the best advantage; but when worked on a tall clean stem and has attained mature age, a weeping beech is an object of great beauty, particularly so when in suitable positions and associated with trees of a light, airy habit, such as the birch and willow. A weeping beech is one of the most persistent of weepers; its branches and even spray hang vertically one over the other in massive flakes or layers, giving it a distinct and singular appearance; and whether viewed in spring, when clothed with luxuriant pale green foliage, or in autumn, when it has assumed a warm brown color, it forms a noble and picturesque object in the landscape. It is, perhaps, seen to the best advantage when planted on the verge of a stream, pond, or lake; but on a steep sloping bank in pleasure grounds, where ample room is given it, or on a rocky eminence in a wild ornamental wood, it forms a telling feature of great interest. One of the noblest specimens exists in Mr. Anthony Waterer's nurseries, at Woking, where there is also a new weeping copper beech, which will eventually prove one of the most valuable of ornamental trees.

The Weeping Ash is a well known weeping tree of vigorous habit, its branches spreading, at first horizontally, but gradually drooping toward the ground. Its strong stiff growth does not render it as graceful and ornamental as many of the trees of this class, but planted singly on a large lawn it forms an interesting object. It is one of the best trees for forming an arbor. Fraxinus excelsior aurea pendula is a variety of the preceding, but scarcely quite so strong growing, and it is characterized by the yellowish bark of the young branches, which give the tree a peculiar appearance. F. lentiscifolia pendula is a pendulous variety of the

THE WEEPING SOPHORA.

The Kilmarnock Weeping Willow is so well known as to need no description, being one of the most popular and widely disseminated of weeping trees. It was discovered growing wild in a sequestered corner of Monkwood estate, near Ayr, in Scotland. The name Kilmarnock weeping willow was given to distinguish it from the common weeping willow and the American weeping willow. Of all weeping trees, it is one of the best, particularly for small lawns. Very handsome plants may be obtained, grafted on stems from 6 feet to 8 feet high, for training into umbrella heads. Grafted low, say 3 feet or 4 feet high, with the head nicely kept and the branches trailing on the ground, it becomes a novel and interesting object on the lawn.

The American Fountain Willow is a well known pendulous variety, which forms a very handsome specimen when budded standard high. While it can be trained in umbrella form like the Kilmarnock willow, it is a much stronger grower, and requires more space. On account of its vigorous growth it is much more difficult to keep in shape than the Kilmarnock, and, all things considered, hardly equal to that variety for ornament planting. It is a trailing species of American willow grafted standard high, and was introduced from France about 1852.

The Weeping Willow is Salix babylonica, with which every one is familiar, and which is so well adapted for choice positions in gardens, cemeteries, or water margins. It is invariably grown from cuttings. S. babylonica annularis or crispa is generally known as the ringlet-leaved willow, and is one of the most picturesque objects to be found in our gardens. It thrives best near water, where it attains the dimensions of a small tree with drooping branches, not, however, like those of ordinary weeping willows, but more after the style of those of a little lime tree. There are some fine specimens of the ringlet-leaved willow in the aboretum at Syon House. S. fuscata is an American willow which has more of a creeping than erect-growing character; it has been lately tried worked as a weeper, being grafted from 4 feet to 6 feet high. The effect has been excellent; thus circumstanced it thrives admirably,

lentiscus-leaved ash, and forms a fine ornament in a sheltered situation. It requires to be grafted some 6 feet in height, in order to show off its true character to advantage, as its branches are very slender and willow-like compared with those of F. excelsior. They are produced in great abundance, this variety of ash making an excellent pendulous umbrella-headed tree.

The White-leaved Weeping Linden (Tilia argentea pendula) is a handsome drooping variety with large round leaves, of a grayish green color above and silvery gray beneath. Worked upon stocks standard high, the branches shoot out almost horizontally, and as they increase in length bend gracefully toward the ground, giving to the tree a decidedly pendulous character. Being a strong grower, it requires to be vigorously pruned to keep it in shape. In this way it can be trained into a round symmetrical head, and will always be found a desirable addition to any collection, on account of its distinct silvery foliage, which contrasts effectively with the deep green of other trees.

Of Weeping Elms there are several which deserve attention. The American elm is one of the most noble and stately of weeping trees. It is so well known that any notice of it here would be superfluous, but it may be proper to remark that it is not admissible on small lawns. The most popular of weeping elms is the Camperdown, a very picturesque and elegant tree, which can be employed with the most satisfactory results in extensive grounds as well as in small garden plats. It is of rank growth, the shoots often making a zigzag growth outward and downward of several feet in a single season. The leaves are large, dark green, and glossy, and cover the tree with a luxuriant mass of verdure. By a judicious use of the knife it can be kept very regular and symmetrical in form, and a handsome specimen isolated on the lawn will always arrest attention and elicit admiration. The Scotch weeping elm (montana pendula) is a drooping variety, resembling the Camperdown, but not so good. The rough-leaved weeping elm (rugosa pendula) is a pendulous variety with large, rough leaves, and Ulmus viminalis is a dis-

tinct slender-branched variety, very ornamental in habit and foliage.

The Weeping Mountain Ash has probably received as much attention as any weeping tree, on account of its distinct and curious habit. A careful examination of its mode of growth cannot fail to excite wonder. If worked 2 feet or 3 feet from the ground and allowed to grow wild, it soon becomes as odd a piece of framework as it is possible to imagine. Grafted 6 feet to 8 feet high, it becomes a very desirable lawn tree, and in the autumn, laden with large clusters of bright red fruit, it produces a brilliant effect.

The Weeping Poplar (Populus grandidentata pendula), although not so elegant and graceful as some of the drooping trees we have mentioned, has many desirable qualities which commend it to the admirers of fine trees. Its character is decidedly pendulous, and its branches spread and droop gracefully toward the ground. But the knife must be used unsparingly to preserve the symmetry. It is the most rapid grower of any in this class, and those who desire a weeper which will produce immediate effect will find their wants amply requited by planting this tree. The black-barked weeping poplar and the parasol de St. Julien are almost similar to the above.

Populus canescens pendula, a variety of the white poplar, forms a beautiful and graceful object, which, at a distance, resembles a weeping birch. It is grafted pretty high on the Lombardy poplar, and prefers a rich and moderately moist soil to one dry and poor. P. tremula pendula, a weeping variety of the aspen, is a desirable and graceful tree for planting near water, but its roots must only be in a moderately moist medium, as continuous saturation would soon kill them.

Weeping Honey Locust (Gleditschia triacanthos pendula) is a most remarkable and beautiful tree. It has every characteristic of habit and foliage to recommend it, but in severe winters it is liable to injury from frost. Its propagation is somewhat difficult, which will always make it expensive and rare Those who love and admire fine trees sufficiently to give them the necessary protection will feel themselves amply repaid for any trouble or expense they may incur in securing a specimen and giving it the protection it requires.

The Weeping Japan Sophora (Sophora japonica pendula), one of the most beautiful trees, loves a warm, free loam and all the sun it can get with us, and it does not fear drought. It is a capital tree for a lawn, and being of comparatively small size, it is well suited for planting in the neighborhood of dwellings. Its branches curve gently and gracefully to the ground, like those of a weeping ash, but much closer and thicker, and when fully clothed with leaves nearly rain proof. As an arbor, therefore, or covering for a rustic seat, few weeping trees are better fitted. It is usually budded on seedlings of the common sophora about 6 feet or 8 feet high, an elevation from which the branches hang down like those of an ash, and on reaching the ground their points spread out or turn up If grafted or budded close to the ground, they send forth shoots like trailers, but unless for banks and rockeries, this habit of growth is undesirable. Loudon speaks of this variety as follows: "The pendulous variety is well deserving of culture as an object of singularity and beauty; and where it is desired to cover a surface with intense green foliage during summer—for example, a dry hillock—a plant of this variety placed on the center will accomplish the purpose effectually. When grafted on the common form at a height of 8 feet or 10 feet or more, the branches fall gracefully on all sides of the stock, and form what one might designate as a leafy cascade of darkest green. I have been unable to trace the history or origin of this variety. Considering its peculiar aspects and good qualities, perfect hardiness, and vigorous growth, it seems strange so charming a tree should not be more frequently planted." Our illustration shows a small specimen of the weeping sophora as a shade tree on a rocky lawn.

Weeping Walnut (Juglans regia pendula), which forms an extremely handsome tree of vigorous growth, the slender branches growing about 6 feet in length in a season, is quite as fertile as the ordinary kind, and so combines usefulness with ornament. A similar remark is applicable to the

Weeping Filbert (Corylus avellana pendula), whose long, slender, and drooping branches form a fine ornament for lawns and shrubberies, or even for the kitchen garden, for its habit of growth in no degree detracts from its productiveness.

The Weeping Holly (Ilex aquifolium pendula) has a truly pendulous character, and is a robust grower, and makes a fine tree for an arbor when grafted about 6 feet high. There is also a beautiful variegated-leaved form of it, and both grow freely when grafted on seedlings of the common holly.

Planera Richardi pendula.—This is the weeping variety of the Zelkowa tree; it produces glonpendent, slender branches, which are pretty well clothed with leaves. It is grafted, several feet above the ground, on the erect-growing variety. It forms a handsome ornament either for lawns, pleasure grounds, or parks.

The Weeping Oak (Quercus robur pendula) is a truly pendulous variety of our common British oak; it grows rapidly and forms a conspicuous object in the landscape when grafted on the common Quercus pedunculata, on which it does well. It is by no means a common tree.

The Weeping False Acacia (Robina pseud-acacia pendula) possesses great merit as an ornamental tree, as it is of rapid growth; the branches soon droop to the ground, and the characteristic graceful foliage of the acacia adds greatly to its effectiveness. A golden-leaved form of this also promises to become a useful plant. The weeping cherries are all pretty lawn trees, but not sufficiently known to be appreciated.

The Weeping Chinese Cherry (Cerasus pendula fl. rosea) is a singularly beautiful small weeping tree, with slender drooping branches clad with delicate rosy flowers.

TRANSFORMATION OF PRISMATIC SULPHUR.

By D. GERNEZ.

THE author studies the influence of the surrounding temperature upon the rate of transformation. It is very slow about 97°, becomes more rapid at decreasing temperatures, reaching a maximum between 55° and 44°, but becoming slower again at lower temperatures. Other factors are: the influence of the temperature at which the prisms have been produced; the influence of the duration of the prisms in the bath where they originated; influence of the temperature at which the sulphur has been melted before its solidification in prisms; influence of the stay of the sulphur in the melting bath; influence of anterior operations to which the sulphur has been submitted.—*Comptes Rendus*, *vol.* c., *No.* 22.

EXCAVATION OF THE GREAT TEMPLE OF LUXOR, UPPER EGYPT.

By AMELIA B. EDWARDS.

OF all ruins, or groups of ruins, in the land of Egypt, the temples and tombs of "hundred-gated Thebes" stand foremost in majesty, variety, and number. Here six great temples, four on the left bank and two on the right, surrounded by innumerable remains of smaller sanctuaries, tombs, mounds, and masses of debris, mark the extent and splendor of a city which for many centuries was, like Rome in a later age, the capital of the known world. Of these six temples, the four on the left bank are known to travelers and readers of travels as Goornah, Dayr-el-Baharee, the Ramesseum, and Medinet Haboo; the two on the right bank being Karnak and Luxor. These names are not old Egyptian. They are the names of modern, or comparatively modern, Arab and Coptic settlements thereabout; one only (*i. e.*, Medinet Haboo) being traceable, it is thought, to one of the many ancient names of the city of Thebes.

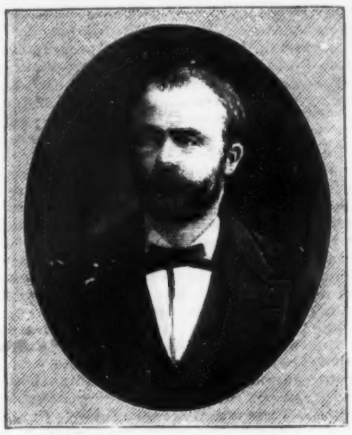
By far the most accessible, and consequently the most familiar, of these half-dozen Theban temples is the great temple of Luxor, which has just been excavated by Professor Maspero, and of which we give five illustrations. It is the only one of the six which stands close to the river side, the others lying far back in the plain, and being but very imperfectly seen from the deck of a dahabeeyah, or steamer. Also, the village of Luxor is the stopping place for all comers. The post-office lies within a stone's throw of the temple. Cook's hotel is equally near, though on the other side of the ruins. The landing place, where steamers, dahabeeyahs, and native trading craft most do congregate, is precisely at the foot of the sand slope leading up from the river bank to the huge colonnade of Horemhebi. Here, too, the consular representatives of England, America, France, and Germany live in provincial state, fly the flags of their respective governments, and exercise a large and genial hospitality. To a traveler coming up the river, Luxor, in fact, seems much more like the capital of Upper Egypt than Siout. He stays longer, sees more, learns more, buys more, and has altogether more enjoyment there than at any other point between Cairo and Wady-Halfeh. Karnak, not one temple but a town of temples; Goornah, the family monument of the first Rameside Pharaohs; Dayr-el-Baharee, where, close by the terraced temple of Queen Hatshepsu, the famous discovery of royal mummies was made four years ago; the Ramasseum, by some called the Parthenon of Thebes; Medinet Haboo, second only to Karnak in extent and splendor—the marvels of the Western Necropolis, and of the valley of the tombs of the kings; all these are within easy reach and form the staple of endless excursions. Regarded as a station for headquarters, Luxor, in short, is unequaled. Yet, till now, Luxor has not in itself been nearly so rich in objects of interest as any of the neighboring sites. Not only was the great temple three parts buried under the accumulated rubbish of ages, but its courts and colonnades formed the actual nucleus of the Arab half of the modern village. For Luxor, like many another Egyptian town, is divided into two camps, Coptic and Arab; that is to say, Christian and Mohammedan. The Copts, or Christians, have congregated at the northward end, round about their church and the houses of their bishop and priests. But the Moslem population has settled, apparently from mediæval times, in and around the temple, at the southward end of the mound. Here, building always with mud bricks crudely dried in the sun, each generation erecting its congeries of hovels on the ruins of the hovels made by its predecessors, the Arabs of Luxor have gone on from century to century accumulating rubbish upon rubbish and mud upon mud, till, like a colony of coral insects, they have thrown up an artificial hill some forty-eight or fifty feet in height. As the hill rose, the temple necessarily became swallowed up, and so effectual was this process of swallowing up, that to those who visited Luxor only six or seven months ago, but a small part of that noble edifice was either accessible or visible.

Any exact description of the building must begin at the beginning, *i. e.*, at the entrance-gateway; although, if taken in chronological order, the farther end would need to be treated first. A pair of red granite obelisks (one of which now adorns the Place de la Concorde, Paris) and four seated colossi preceded the great double pylon, or two-towered gateway, which is yet almost perfect. This leads to a courtyard measuring 190 ft. by 170 ft., which courtyard is surrounded by a peristyle, consisting of two rows of massive columns. Hence a second and smaller pylon opens upon an avenue of fourteen giant pillars, seven on each side, known as the Great Colonnade of Horemhebi. A third pylon, of which only one corner remains, next gave access to the second court, an inclosure scarcely inferior to the first, measuring 155 ft. by 167 ft., flanked to right and left by a double row of columns, and leading to a covered portico, the roof of which is perfect, and is supported by thirty-two pillars. This portico measures 57 ft. by 111 ft. Beyond the portico, and opening from it, is a series of pillared halls, corridors, and side-chambers, originally numbering, according to Lepsius' plan, no less than thirty. Many of these are yet intact, including the sanctuary, or Holy of Holies. This last is separately roofed and inclosed, like a building within a building; the sculptured surfaces of its walls, as of the walls of the chambers round about, being in admirable preservation. As for the roof of the temple, it is so solid that a large modern house of crude brick was constructed upon it, as upon a lofty stone platform, about a century ago, and there remained, though in a somewhat ruinous condition, till the beginning of the present year.

Such, very briefly outlined, is the general plan of this magnificent structure, which, when perfect, cannot have measured much less than 800 ft. from end to end. Like most other great historic temples of ancient Egypt, it was the work of many builders, and was carried on through many centuries. The original sanctuary and surrounding chambers, the portico, and the smaller court were built by Amenhotep III., ninth Pharaoh of the eighteenth dynasty. This part dates, therefore, according to Mariette and Manetho, from about B. C. 1530. The great colonnade of fourteen columns is ascribed to Horemhebi, last king of the same line, and may be placed about eighty years later. The first and largest court and the great entrance-pylon, as well as two granite obelisks and four seated colossi in the open space in front of the temple, were the work of Rameses II., about B. C. 1360. Finally, the ancient sanctuary of Amenhotep III. having been destroyed by the Assyrians, the present one was erected by Alexander Ægus, son of the great Alexander, what time Ptolemy Lagus, surnamed Soter, was nominal governor, and actual ruler, of Egypt. This brings us to about B. C. 315, or from that to B. C. 312. Latest of all, we find the abaci of certain columns inscribed with the names of Ptolemy Philadelphus; but as these are merely inserted upon vacant spaces in older work, it may be assumed that the last actual builder was Ptolemy Lagus, acting for Alexander Ægus. Reckoning, therefore, from Amenhotep III. to the son of the Macedonian conqueror (*i. e.*, from B. C. 1530 to B. C. 312), we arrive at a total of 1218 years during which the temple was in course of construction. For so long as the nation continued to venerate the old gods and to observe the old order of things, it may be taken for granted that the temple and its precincts were held sacred. Not till after the abolition of the ancient religion and the forcible establishment of Christianity in Egypt by the Emperor Theodosius I., in A. D. 379, is it therefore at all likely that the courts and colonnades of this magnificent structure were desecrated by squatters from without. That they settled upon the temple, sooner or later, like a swarm of mason bees, is at all events certain; and the extent of the mischief they perpetrated in the course of centuries may be gathered from the fact that they raised the level of the surrounding soil to such a height that the obelisks, the colossi, and the entrance-pylon were buried to a depth of 40 ft., while inside the building the level of the native village was 50 ft. above the original pavement. Seven months ago, the first court contained not only the local mosque, but a labyrinthine maze of mud structures, numbering some thirty dwellings, and eighty straw-sheds, besides yards, stables, and pigeon-towers, the whole being intersected by innumerable lanes and passages. Two large mansions—real mansions, spacious, and, in Arab fashion, luxurious—blocked the great colonnade of Horemhebi; while the second court, and all the open spaces and ruined parts of the upper end of the temple, were encumbered by sheep-folds, goat-yards, poultry-yards, donkey-sheds, clusters of mud-huts, refuse-heaps, and piles of broken pottery. Upon the roof of the portico, as before stated, there stood a large, rambling, ruinous old house, the property of the French government, and known as the Maison de France; while, between the temple and the river, as if put there on purpose to hide the little that was yet visible of the work of the Pharaohs, extended a series of blank-eyed, hideous, whitewashed public offices—namely, the Khedivial prison, police barrack, post office, and government stores.

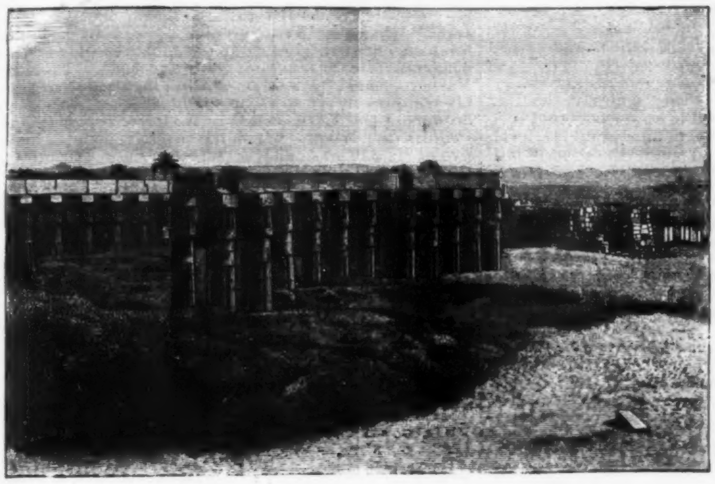
To sweep away all these barracks, stores, houses, huts, pigeon-towers, stables, and refuse-heaps; to clear the grand old temple down to the bases of its columns and the level of its pavement; to do, in short, for Luxor what Mariette did for Edfoo and Abydos, has been the earnest desire of Professor Maspero ever since his acceptance of the important post left vacant, in 1881, by the death of Mariette Pasha. Visiting Luxor in the month of April in that year, he noted with dismay the rapid destruction which was everywhere going on, both on the inside and outside of the temple, Not only had the sculptured surfaces suffered wherever they were within reach, but every exposed part of the walls and columns served for a quarry, from which all comers were free to extract building stone as they required it. To save the building was evidently an imperative duty; but to save it without evicting its destroyers was impossible. The problem was, therefore, how to effect the excavation of a site consecrated by the presence of a Mohammedan mosque, and usurped by families whose prescriptive rights dated back for many generations. But Maspero was not be daunted. He succeeded in laying his statement before the Egyptian Minister of Public Works, and in obtaining the necessary authorization for treating with the fellaheen, the basis of the negotiation being that each squatter should receive a cash indemnity for his house and a piece of land equivalent in extent to the area covered by the said house and its dependencies. It was further arranged that the Egyptian government should find the money for the liquidation of the indemnities. It might be supposed that when all these essential preliminaries were settled, the worst difficulties were already overcome, On the contrary, however, they had scarcely begun. The mere measuring of the ground, the bargaining, the adjudication of conflicting claims, and the work of valuation dragged on for nearly two years. Some of the temple-folk would sell, and some would not. Some were readily content, whereas others asked exorbitant prices. Indemnities varying in amount from 8 f. or 10 f. per house to as much as 3,000 f. were actually paid; but Mustapha Aga, a wealthy Arab gentleman who acts as consular agent for Great Britain, and one or two others, stoutly refused to be bought out, except upon such terms as made negotiation well nigh impossible. Meanwhile, there was another financial question to be settled, namely, the expenses of excavation. The Egyptian government had paid the indemnities, and could do no more; yet, to get rid of the squatters was of little avail so long as there remained fifty feet of soil to be cleared and carted away. A subscription simultaneously started in the *Journal des Debats* and the *Times* met, however, with so liberal a response (especially in Paris) that this question of ways and means was settled in two or three days, and forthwith—that is to say, in the month of July, 1884—the order was given to commence operations.

In Egypt, as in some other places, it is one thing to give an order, and it is another thing to get it obeyed. Having touched their money and made sure of their land, the temple-folk declined to turn out. The local police sympathized, as a matter of course, and the local authorities supported the local police. A company of engineers, sent up from Cairo to conduct the excavations, lounged about Luxor for a few days, and then, finding their mission unpopular, "marched back again." Nothing, in short, was done; and when Pro-

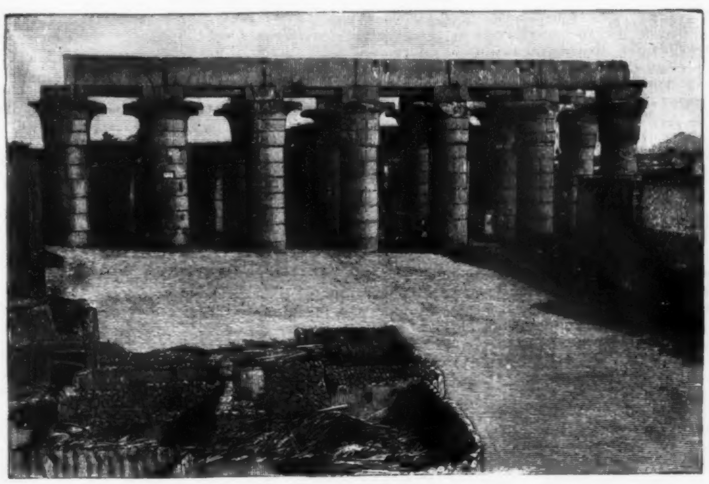


PROFESSOR MASPERO,
DIRECTOR-GENERAL OF THE MUSEUMS, EGYPT.

EXCAVATIONS GOING ON IN THE COURTYARD OF AMENHOTEP III



GREAT COURTYARD OF AMENHOTEP III.



COLONNADE OF HOREMHEBI.

COLUMNS OF AMENHOTEP III.

GREAT TEMPLE OF LUXOR (SOUTHERN END) BEFORE THE EXCAVATIONS: WITH LADY DUFF GORDON'S HOUSE

EXCAVATION OF THE GREAT TEMPLE OF LUXOR UPPER EGYPT.

fessor Maspero, after a brief vacation, returned to the scene of his winter labors, he found the temple area as densely populated as ever. The police, it is needless to say, were immediately called in, and compelled to do their duty; the recalcitrant squatters were ejected, and the work of demolition began. At first, the main difficulty was to get laborers. Egged on by the antiquity dealers of Luxor, who are, as ever, the vowed opponents of Boulaq, the villagers hung back. Not so, however, the fellaheen of the surrounding hamlets. The Karnak, Medamot, and Bayadieh folk flocked in readily for the work and the wages; whereupon the Luxorites repented, and a lively competition ensued. By the middle of January, there were some fifty men wielding pick and spade at the upper end of the temple, and some 200 boys and girls carrying rubbish. On Feb. 26, writing from Luxor, Professor Maspero was able to say: "The following, after only two months' work, is the progress made by our excavators: Southward, the old Maison de France is demolished, and the sanctuary and its surroundings stand completely free. Northward of the Maison de France, the police barrack, the government stores, and the post office have disappeared. As far as the central colonnade, (*i. e.*, the colonnade of Horemhebi, the great courtyard of Amenhotep III. is now in full view from the river. The columns are excavated to two-thirds of their height, and the long-buried ruins of the central pylon begin to show above the debris. At the northern end, our work advances more slowly. The inhabitants are mostly dislodged, and their dwellings leveled; but the mosque still occupies one corner of the first courtyard, and seven houses yet stand as if islanded in the midst of the rubbish. I have, however, reason to believe that the wrong-headed resistance of even these obstinate owners will be withdrawn before another month has elapsed. Meanwhile, a great gap has been opened in this first court, and the sides of the pylons are cleared. A small portico of the time of Rameses II. has come to light; and several colossi in red granite have been discovered, some prostrate, and others yet upright in their places. Our excavations have also revealed some new and interesting facts. We now know that the temple was not originally separated from the Nile by the present shore slope. It rose straight from the water's edge, like the covered gallery at Philæ, being bounded at the southern end by the small canal which still opens thence at right angles to the river, and washed along its westward walls by the river, which now flows at a distance of several hundred yards. The lower wall, that is to say, the wall which served for a quay, was constructed with huge blocks of dressed stone, headed by a frieze inscribed with the names and titles of Amenhotep III., and surmounted by a sculptured and painted cornice. At a later age, during the period of Roman rule, when the mud had accumulated and the Nile had consequently retreated, a gigantic quay was built between the temple and the river; and it is to the remains of this quay that Luxor at the present day owes its immunity from the encroachments of the annual inundation."

After writing to the above effect, Professor Maspero continued the work of excavation for yet another month, by which time the splendid columns of the Court of Amenhotep were cleared to their bases, the ancient pavement was in part laid bare, and a magnificent vista was opened from the very portico at the southward end to the great entrance-pylon at the north. Much yet remains to be done; but already this noble Pharaonic structure is well nigh without a rival on the banks of the Nile. Even Maspero, whose judgment is always temperate, does not hesitate to aver that the sculptured surfaces of the walls and columns where recently uncovered are worthy to rank beside those of Abydos, and that, "for grandeur of design and beauty of proportion, the great Temple of Luxor is almost the equal of Karnak."

Of our five illustrations, two represent the old condition of things, and three the new.

THE GREAT TEMPLE OF LUXOR (SOUTHERN END) BEFORE THE EXCAVATIONS WERE BEGUN.

In this view, the principal foreground object is the old government store house, with its yards and offices. The spectator looks southward, having the Temple, the eastward plain of Thebes, and the so-called "Arabian" chain of mountains to his left. On his right, at the foot of a long sand slope, flows the yellow Nile, which, however, is not seen in our illustration. The distant summits of the Arabian chain are just visible above the architraves surmounting the lateral colonnades of the courtyard of Amenhotep III.; these colonnades, which consist of twenty-four columns placed two deep on each side of the courtyard, being completely masked on the side of the river by the unsightly government stores before mentioned. Where the colonnade is seen to end, the portico of Amenhotep III. actually begins; but this portico, and all the roofed part of the Temple, is concealed by the large, rambling, whitewashed house, whose few windows face the Nile. This house, now demolished, is the famous "Maison de France." Within its walls the illustrious Champollion and his ally, Rosellini, lived and worked together in 1829, during part of their long sojourn at Thebes. Here the naval officers sent out by the French in 1831, to remove the obelisk which now stands in the Place de la Concorde, took up their temporary quarters. And here, most interesting to English readers, Lady Duff Gordon lingered through some of her last winters, and wrote most of her delightful "Letters from Egypt." A little balcony with a broken veranda and a bit of latticework parapet juts out above some mud walls at the end of the building. Upon that balcony she was wont to sit in the cool of the evening, watching the boats upon the river and the magical effect of the after-glow upon the Libyan mountains opposite. All these buildings, Maison de France, stores, yards, etc., were yet standing in December last. They are now all swept away; and our next illustration shows the aspect of the same spot, from a somewhat higher point of view, as it appeared toward the end of February.

GREAT COURTYARD OF AMENHOTEP III., PARTLY CLEARED (GREAT TEMPLE OF LUXOR).

Both wings of the lateral colonnades to the courtyard of Amenhotep III. are here shown. The courtyard within, which was full of hovels and stables, and the outer space previously occupied by the government stores and yards, are piled with the debris of demolished buildings. The Maison de France is gone, all but the remains of the little balcony, which just shows above the top of a temporary hoarding. The massive masonry of the upper end of the Temple (*i. e.*, of the sanctuary and surrounding chambers) is now visible, the intervening mud walls being leveled to the ground.

COURTYARD OF AMENHOTEP III. (GREAT TEMPLE OF LUXOR); THE EXCAVATIONS IN PROGRESS.

We here find ourselves admitted into the precincts of the courtyard, immediately behind the government store house, of which one corner and a small window are seen between the pillars to the right. The spectator stands with his back to the Arabian chain and his face to the Libyan range, one long spur of the great western mountain and a glimpse of the Nile being visible behind the highest group of Arabs to the left of the picture. The mud huts, the mud walls built up between the columns, the asses and goats and village folk, are still in part occupation of the place. To the left, however, a hovel or two have been demolished, and on the rubbish heap thus created we see a group composed of two Europeans—probably overseers—and some five or six better class natives. The excavators in the foreground, who are engaged in removing debris, have paused in their work while their portraits are being taken.

THE COLUMNS OF AMENHOTEP III., EXCAVATED NEARLY TO THEIR BASES (GREAT TEMPLE OF LUXOR).

The point of view is very nearly the same as in the foregoing subject, the group of columns being identical with most of those there represented. The mud walls between the shafts are, however, knocked away, and the area is cleared as far as the boundary wall of the government store. The soil is now excavated to a depth of some 12 ft. or 14 ft. below its previous level, and in some places the pick and spade have gone still deeper, as may be seen by the figure of the Arab standing in the pit at the foot of the near column. They will have to go some five feet lower still, before they come to the bases of these noble shafts and the plinths on which they stand. The design is one of the most beautiful among the orders of Egyptian architecture. It conventionally represents a bundle of lotus plants, stalks, and buds; the stalks bound together at the top by a ligature, and the cluster of buds forming the capital. Upon the abacus of each capital is sculptured in hieroglyphic characters the name of Amenhotep III. (popularly known as Amenophis) inclosed in a royal oval. We may remind our readers that the famous pair of sitting statues, so familiar in photography and art, known as the "Colossi of the Plain," are portraits of this great Pharaoh.

Grouped in the middle of the foreground, we see a dozen or thirteen persons, chiefly Europeans. The central figure, and the tallest, wears upon his head the distinctive "tarboosh," or "fez," of a government official, and round his waist, in Oriental fashion, a broad scarf of Syrian silk. This is Professor Maspero, Director-General of the Museums of Egypt. He is surrounded by a group of friends and fellow workers, among whom may be seen MM. Lefebure, Bouriant, and Loret, of the *Ecole Archeologique* at Cairo; Mr. Wilbour, an American student of Egyptology; and M. Gabriel Charmes, of the *Journal des Debats*. The scale is, however, too small for recognizable portraiture. The lady who leans against the column to the left is Madame Maspero, the young, charming, and intrepid companion of Professor Maspero in all his expeditions.

THE COLONNADE OF HOREMHEBI (GREAT TEMPLE OF LUXOR).

Until the present excavations made the southern end of the Temple visible from the river, the great colonnade of Horemhebi was the only part of the splendid structure which the Nile traveler could see from the deck of his dahabeeyah. These fourteen huge sandstone columns, with their enormous bell-shaped capitals and massive architraves, stand two deep, and are of a rich amber hue, as if steeped in the sunsets of 3,000 years. Severely simple, they crown the ridge and face the river. If excavated to their bases, they would measure about 57 ft. in the shaft, and stand out clear against the sky. But they are buried for half their height, and a large, irregular house of sun-dried brickwork is built against and between the inner row, thus blocking out the light and converting one of the grandest colonnades ever designed by a Pharaonic architect into the facade of an Arab dwelling. This house which so mars the beauty of the scene is the abode of Mustapha Aga, the venerable and hospitable British Consul. Pleasant as he has long made it to English travelers in Egypt, and endeared to us as it is by memories of the British flag floating cheerily in front of its doors, we must all hope that some arrangement may ere long be concluded whereby the owner shall be induced to build a British consulate elsewhere.

Our illustration represents the scene as it has looked for many years, and as, in its essential features, it looks still. To the right, we see the north end of the government stores, and in the foreground a mud built house and yards, both now demolished. But the sand slope leading up from the river's edge; the great pillars bathed in afternoon sunlight; the British consulate with its projecting portico, lofty flight of steps, arched doorway, flagstaff, and group of retainers sitting outside, are shown *in statu quo*. The colonnade of Horemhebi may be ascribed, according to Mariette and Manetho, to about B. C. 1450, and it belongs to an extremely interesting but brief period of Renaissance in Egyptian art. Manetho, it may be as well to add, was a native of Sebennytus, in the Delta, and held the office of High Priest and Archivist of the Greek Temple of Ra at Heliopolis under Ptolemy Philadelphus. He wrote a "History of Egypt," now lost, of which only a few fragments, and a list of all the kings, have survived to the present day.

PROFESSOR MASPERO.

Professor Gaston Maspero succeeded the late Mariette Pasha as Director-General of the Museums of Egypt in January, 1881. In Egyptology, Professor Maspero is the most brilliant and distinguished pupil of the famous Vicomte E. De Rouge. He is also a professor at the College de France, and was last year elected a member of the Academie des Inscriptions. M. Maspero is yet on the sunny side of middle life, and already he has attained the highest honors which science has to bestow. He is not only an Egyptologist of the first rank, but he is also a fine Semitic and classical scholar, and a master of most European languages. His literary style, when writing in his own language, is singularly subtile and delightful; and as an art critic his judgment and insight are very remarkable. Professor Maspero is editor and proprietor of that admirable scientific periodical called *Recueil de Travaux Relatifs a la Philologie et a l'Archeologie Egyptiennes et Assyriennes.* To this work he is now contributing a series of invaluable transcriptions and translations of the hieroglyphic texts discovered in the recently opened pyramids of Teta, Pepi, and other very early kings. His celebrated essay, "La Jeunesse de Sesostris," was published in 1867, when he was almost a youth; an essay which has thrown an unexpected and very important light upon one of the principal pages of Egyptian history. In his knowledge of the structure of the ancient Egyptian language Professor Maspero is probably without a rival, as may be judged by his innumerable papers on grammatical subjects in the *Zeitshrift fur Ægyptische Sprache*, his essay on the forms of the conjugation in Ancient Egyptian, Demotic, and Coptic, and in the footnotes to his famous essay entitled "Du Genre Epistolaire chez les Egyptiens de l'Epoque Pharaonique" (1872). Of his numerous translations of Egyptian papyri, we have no space to take note in this place; but his most recent and most popular works, the new "Guide au Musee de Boulaq" (1884), and his charming little volume of ancient Egyptian folklore, entitled "Les Contes Populaires de l'Égypte Ancienne" (1882), must not go unrecorded. Professor Maspero is also the author of a luminous and admirably comprehensive work on the history of the early nations of the East, called "Histoire Ancienne des Peoples de l'Orient," which has already gone through five or six editions, and of which a new edition, embodying the latest discoveries in Egyptology, Assyriology, etc., is now in the press. Our portrait is engraved after an admirable photograph by Reutlinger.—*Illustrated London News.*

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